THE

ELECTRICAL REVIEW.

VOL. XXXIII. AUGUST 18, 1893. No. 821

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THE ST. PANCRAS ELECTRIC LIGHTING.

IN a recent issue we mentioned that a memorandum had been drawn up by a Mr. Clements, a member of the Vestry of St. Pancras, in which it was asserted that there had been a loss on the working of the electric light station belonging to that body, which amounted to £6,500 in 1892, and that there would probably be a loss of nearly £5,000 on the current year's working. A statement so diametrically opposed to that put forward by Mr. Gibb, the town clerk, on the authority of the Vestry's technical adviser, Prof. Robinson, who estimated a profit of £4,000 on the current year, naturally demanded examination, and Mr. Gibb and Prof. Robinson were instructed to report on Mr. Clements's memorandum. These reports, together with the original memorandum and a further reply on the part of Mr. Clements, have been reprinted, and the perusal of these extracts from the Vestry minutes are certainly not calculated to inspire the reader with admiration of the method in which the discussion has been carried on. As the results prophesied on the one hand and the other are both supposed to be deduced from the financial statements already published, we expected to see a simple statement of the figures which have served as the basis of calculation, with a detail of the estimates based on them; but instead of this we find in this reprint referred to, many pages devoted to matter of a recriminatory character which has nothing to do with the question under discussion; in fact, what should have been a temperate examination of the details of balance-sheets seems to have resolved itself into an unseemly squabble, in which personalities occupy a prominent position.

As regards the estimated profit and loss accounts for the current year, the most important data published are given in the financial return for the quarter ending March 31st, 1893, from which we find that 116,300 units were supplied to private consumers at a works cost of 2·75d. per unit, and about 53,100 units for public lighting at a works cost, including the carbons for the arc lamps, of 3·20d. per unit. Since these figures are obtained during a winter quarter, when the load factor is certainly more favourable than during the two summer quarters, we should have thought that it would not be safe to take lower costs as the average of the year, as the last winter quarter would then have to more than make up by its improved load factor for the falling off which naturally occurs during the summer; but we find that the estimate presented by Mr. Gibb is based on figures more favourable than those resulting from the first quarter's working. He estimates an income from private consumers of £12,135, equivalent, if we assume that the number of units sold at 3d. and at 6d. remain in the same proportion as during the first three months of the year, to an output of 500,000 units; whilst the output for public lighting is taken

at 160,000 units, since he estimates that £4,000 must be paid for it if 6d. per unit is charged. Taking the works costs per unit as above, the expenditure per annum would amount to £7,860, whilst Mr. Gibb's estimate is £7,290, or, on the other hand, the units that could be supplied on the same basis for £7,290 would be 160,000 for public lighting, and about 450,000 for private, the income from the latter being thus reduced to about £11,000.

Mr. Clements calculates in a different way, and one which we cannot consider reliable, as he takes the gross profit, that is, the difference between gross receipts (including the sale of current for public lighting), and works cost for the first quarter, and he assumes that the other winter quarter will give the same results, and that each of the summer quarters will yield $\frac{1}{4}\frac{9}{4}$ths of the gross profit of a winter quarter. In this way he arrives at a gross profit on the year's working of £7,555 as compared with £8,845 given by Mr. Gibb. It will be seen that, although there is a difference of nearly £1,300, it is not in this part of the estimate that the difference between a profit of £4,000, and a loss of £5,000, is to be found, and we must therefore look to the subsequent proceedings for an explanation. Mr. Clements deducts from the gross profit the annual charge for interest and repayment of the loan, an annual charge for depreciation, a sum for rates and taxes, and the excess of the sum paid out of rates for the arc lamps over that previously paid for the gas lamps which they replaced; whilst Mr. Gibb only deducts the annual charge for interest and repayment of the loan. Now, taking Mr. Gibb's figures, and deducting the charges for interest and redemption fund, leaves a balance of £3,737, or, in round numbers, the £4,000 which he claims as profit; but it is evident that the rates cannot possibly profit to this extent, as they are now charged with £4,000 for arc lamps instead of £1,340, which was the cost of the gas, and we consider that Mr. Clements is quite justified in deducting the difference of these two sums, as the profit of £4,000 can only be obtained by taking the money out of one of the Vestry's pockets to put it into that other one which holds the receipts of the electric light station. If this deduction is made (and its justice is practically acknowledged by Mr. Gibb in an alternative statement of the balance-sheet, in which he says that if the arc lighting is not charged on the rates, then the expenditure and receipts of the station are practically equal, and the Vestry light this district for nothing, and therefore save the £1,340 previously paid for gas), we find that there is a balance of £1,077 left, and a disputed liability in respect of depreciation and rates.

Of these two, depreciation is much the more important, and Mr. Clements charges the undertaking with £3,400, this being the sum allowed by Prof. Robinson in his estimates when the station should be in full working order, whilst Mr. Gibb allows nothing for depreciation, because the machinery is kept in good condition by continuous repairs, and the capital is being gradually paid off by the annual charge for the redemption fund. Although it is a common practice with supply companies in their early days to allow nothing for depreciation, or only a very small sum; this practice cannot be defended, except when the balance of the year's working is on the wrong side, so that a depreciation fund, if created, would exist only on paper; and we are certainly surprised to see that Prof. Robinson appears to accept Mr. Gibb's contention that nothing should be allowed for depreciation. Prof. Robinson states in his report that the sum of £3,400 only applied when the plant is producing the maximum output, and complains of Mr. Clements's unfairness in adopting this sum for the first year, but in the same report he says that the maximum number of lamps which the present plant is capable of supplying (namely, 13,000 lamps of 16 C.P. installed, or 10,000 in use simultaneously) has already been nearly reached, and he estimates an output for the current year of about 500,000 units. In a further letter he claims that the station is already earning a dividend of 4 per cent., and yet he appears to think that the time has not yet come when any charge should be made for depreciation. As regards the effect of a redemption fund, relieving the Vestry of the need of charging depreciation, it is certainly true that, as Mr. Clements says, even if one allows the excessive life of 42 years for the plant, the fact that the original capital will have been paid off at the end of this period will be but poor comfort if it all has to be borrowed again to put in new plant, and therefore depreciation must always be provided for.

If we sum up the results of our examination, we find that the profits and losses predicted by one side and the other are both exaggerated, but that if depreciation is allowed for, as we consider it should be, the net profit of £4,000 will certainly have disappeared, and in its place will be found a loss not of £5,000, but of a sum varying between nothing and, say, £2,000, according to the charge made for depreciation.

"A-lighting" of 'Buses.

The latest electrical rebus is *re* 'buses, and a-lighting of 'buses. There were 150 'buses a-lighting at Victoria Station, Pimlico, narrowly watched by a representative of the technical press. They were not painted "rosy," but a plain royal blue, so that the one which should have gone down Bond Street broke away and ran into Salisbury Court, Fleet Street. It is said that the horses shied at the man who was watching so narrowly, taking him for Sherlock Holmes. This 'bus was supplied with lamps on the near side, of £3 10s. original cost, to be renewed at 1s. 6d., any distance, the charge to be by contract all the way. With these 'buses "you have to pay for what you put in, and not for what you take out"; so that you ride free on top, and pay pirate prices inside. There is no extra charge for recapitulation, in fact you can go round in a circle for three weeks and then find yourself at the starting place, having to confess to an utter inability to proceed further without refreshment. There is not the slightest harm done to the 'bus during this time; it looks, if anything, more cheerful. As a general rule omnibus proprietors cannot be expected to have any clear idea about the ways of London, at any rate as regards the wickedness of the technical press; they may ken somewhat about "leaders," but they are ignorant of those who are responsible for the current literature. It is only lately that they have had an opportunity of observing how wanting in *esprit de corps* are some of its votaries; from their innocence and awkwardness we scarcely know what they are "driving at," and we wonder whether they have ever been on a 'bus before.

Sterilising Milk by Electricity.

There have been many proposals to sterilise water by means of electricity, some of which have, we believe, eventually met with a measure of success. It is now proposed to deal with

a much more difficult fluid, more difficult because of the large amount of *pabulum* for micro-organisms which it contains. The milk to be sterilised is submitted to the action of a strong alternating current of electricity, which is applied to the milk in the ordinary dairy utensils; or the process may be worked continuously by passing the milk at a suitable rate through a long narrow trough, fitted with a series of metallic plates connected with the poles of the source of electricity. The inventors hail from Holland and are F. J. Haarlem and C. Henny. It is stated that by this process all microbes that may be present in the milk, whether derived from the air, the vessels, or diseased cows, are destroyed, and that the risk of transmitting infectious maladies through the medium of the milk is obviated.

A sign of the Times.

THE presidential address delivered before the Society of Chemical Industry on the occasion of the twelfth annual meeting by Sir John Evans, K.C.B., F.R.S., &c., comprised a scholarly review of the progress of chemical knowledge since 1841, and its application to the great industries. He dwelt upon the close relationship which exists between chemistry and physics, and, referring to the domain of electricity, he submitted that it was hard to say whether that science does not owe as much to chemistry as chemistry does to it. He called upon chemists to devote more attention to the study of secondary cells with a view to extending their range of usefulness and developing the theory of their action. Referring to the production of high temperature, he stated that electricity had placed at the command of chemistry a greater intensity of heat than can be derived from ordinary sources. Amongst other topics of interest to electricians, Sir John Evans dealt with the competition which coal-gas has to suffer from electric lighting, and, whilst admitting that gas is losing ground as an illuminant, it seems, he said, to be gaining it as a source of power. He might also have added that this gas is being more largely used as a thermal agent. It is gratifying to have the views which we constantly place before our readers so amply confirmed by such high authority, and once more we give the gas companies some friendly advice. Let them accept the inevitable; let them recognise that coal-gas as an illuminant *is* losing ground, and awake to the fact that a new field of enterprise is awaiting them. When they can cheaply produce a gas of low illuminating power which shall be suitable for thermal and power purposes, the shrinking dividends will perhaps surpass their old dimensions.

Long-distance Telephony.

THE mathematics of telephony have received an important addition from Prof. Perry, whose paper in the August number of the *Philosophical Magazine* is worthy of attentive study. When resistance, capacity, self-induction, and leakage are taken into account, the subject of long-distance telephony becomes one of considerable difficulty. It is given to very few men to be able to discuss complicated mathematical formulæ without making mistakes. The proceedings of scientific societies possess many such mistakes detected and undetected—and, consequently, Prof. Perry has adopted the plan of instructing his students to experiment with their formulæ, using numerical values for their variables. The consideration of the most general problem of long-distance telephony involving certain terminal conditions, has been taken up by Mr. Heaviside; but the ordinary mathematical physicist must find great difficulty in understanding the investigation (*Phil. Mag.*, January, 1887). Some of Prof. Perry's students have, therefore, turned their attention to obtaining numerical results (neglecting the terminal conditions), which appear to be not only instructive but to possess a permanent value. These are given in the present paper and are of very considerable practial interest. In concluding his paper, Prof. Perry says: "If some of our clever mathematicians would, for a while, put aside the ambition to write original papers, and would give us in one paper, however long, an exposition of Mr. Heaviside's views on this subject of long-distance telephony, they would confer great benefits upon the average electrician; for Mr. Heaviside can discover new truths, and we all believe in his results, when we understand them, but he seems unable to lower his reasoning to average mathematicians' levels."

Marble Making by Electricity.

THE manufacture of marble is usually left to Nature, and human beings have no reason to be dissatisfied with the results of this arrangement; but the "dare-anything" notion with which the modern scientist is praiseworthily imbued, leads him continually to compete with the natural forces and often with success. To-day he has realised the artificial production of marble—a feat of no commercial importance, but strikingly illustrative of the "almightiness" of the human mind. Mons. H. Le Chatelier, who is, perhaps, the "Roberts-Austen", amongst French scientists, has recently succeeded in producing marble from pure calcined carbonate. This substance in the form of an impalpable powder, was enclosed in a steel cylinder and compressed between two steel pistons with a pressure of 1,000 kilogrammes per square centimetre. While in this condition, a platinum spiral previously embedded in the powder, was heated by an electric current, with the result that the powder in the neighbourhood of the wire was rendered crystalline and translucent. Sections of the resulting substance when examined under the microscope exhibited the characteristics of certain specimens of slightly macled marble. An achievement of this order, even though it may be useless from an economic point of view, is none the less interesting and encouraging.

A New Photometer.

IT is often desirable in the study of simultaneous contrast colours to have large surfaces coloured by contrast, so that we can the better match the colours of these surfaces with rotating coloured discs, and thus arrive at quantitative statements of their hues. This is especially desirable in ascertaining the hues of the light of flames, and of the arc electric light when compared with daylight, or when compared with other lights. The result of many experiments is the apparatus described by A. M. Mayer in the August issue of the *Philosophical Magazine*. In a short notice it is not possible to give a clear account of this new photometer, but we observe that many of the experiments described are of great interest to electricians, especially those on simultaneous contrast colours produced by the flash of the electric discharge. The light used was obtained from the discharge of a Holtz induction machine. The paper comprises an interesting explanation of the phenomena of simultaneous contrast colours which ought not to be missed by students of photometry.

STATISTICS OF THE EUROPEAN ELECTRICAL TRAMWAYS.*

GERMANY.

1881. BERLIN-LICHTERFELDE.—*Siemens and Halske system.*—Length, 3·6 kilometres; gradient, 1 in 100. 4 self-motive carriages. Gauge, 1 metre. Overhead line, 165 volts. Works supplying 2 × 30 steam horse-power. Worked by the firm of Siemens and Halske. In 1892 100,800 car kilometres were traversed. The cost per car kilometre is 22 pf.

1884. FRANKFORT-OFFENBACH.—*Siemens and Halske system.*—Length, 6·7 kilometres, R. = 30, maximum gradient, 3 in 100. 10 motive cars drawing 6 carriages. Double overhead line, 4 dynamos, 300 volts, 70 ampères. Worked by the Frankfurt-Offenbacher Trambahn Gesellschaft. The cost per car kilometre is 19·8 pf.

1891. HALLE.— *Sprague system.* — Length, 7·8 km., R. = 15, maximum gradient, 5 in 100. 25 carriages, with 2 motors of 12 H.P. Gauge, 1 metre. One overhead return wire along the rails, 500 volts, 120 ampères. Mean speed, 9 kilometres per hour. Worked by the Allgemeine Elektricitäts-Gesellschaft, of Berlin. A second line was established in October, 1892, with 10 carriages by the same makers.

1892. BARME.—*Siemens and Halske system.*—Length, 1·7 kilometres, R. = 150; gradient, 16 in 100. 8 self-motive carriages; 2 machines of 200 H.P., 500 volts. Worked by the Barmen Bergbahn Gesellschaft.

1892. BREMEN.—*Thomson-Houston system.*—Length, 10·3 km.; 2 steam engines of 140 H.P.; 500 volts, 160 ampères; gradient, 3 in 100. 25 self-motive carriages for Sunday work. Worked by the Bremen Strassenbahn Gesellschaft.

1892. DRESDEN.—*Siemens and Halske system.*—Length, 6 kilometres, R. = 13; gradient, 5 in 100. 12 self-motive carriages, 2 steam engines of 120 H.P., 500 volts.

1892. GERA.—*Sprague system.*—Length, 12·3 kilometres, 500 volts; 18 carriages with 2 motors of 12 H.P. Worked by the Gera Strassenbahn Gesellschaft; constructed by the Allgemeine Elektricitäts-Gesellschaft, of Berlin.

1892. HANOVER.—*Siemens and Halske system.*—Length, 12 kilometres; gradient, 2 in 100. 14 self-motive carriages, 2 machines of 200 H.P., 500 volts. Worked by the Tramways Company of Germany, Limited.

1893. BRESLAU.—*Sprague system.*—Length, 29 kilometres, 9 being underground; 500 volts. Gauge, 1·435 m. 40 carriages with 2 motors of 2 H.P. Worked by the Breslau Elektricitäts Strassenbahn Gesellschaft; constructed by the Allgemeine Elektricitäts-Gesellschaft, of Berlin.

1893. ESSEN.—*Sprague system.*—Length, 20 km.; 500 volts; 20 carriages with 2 motors of 15 H.P. Constructed by the Allgemeine Elektricitäts Gesellschaft, of Berlin.

1893. CHEMNITZ.—*Sprague system.*—500 volts. Constructed by the Allgemeine Elektricitäts-Gesellschaft, of Berlin. Worked by a local company.

1893. LUBECK.—*Sprague system.*—Length, 7 km.; 500 volts; 24 carriages, each with 2 motors of 15 H.P. Constructed and worked by Allgemeine Elektricitäts-Gesellschaft, of Berlin.

1893. REMSCHEID.—*Thomson-Houston system.*—Length, 7·7 km., 7 carriages with 2 motors of 15 H.P.; gradient, 10·92 in 100; 1 generator, 90,000 watts.

GOTHA.—*Thomson-Houston system.*—Length, 2·6 km.; gradient 3 in 100, 5 carriages. (In contemplation.)

ERFURT.—*Thomson-Houston system.*—Length, 9·8 km.; gradient, 3 in 100; 29 carriages. (In contemplation.)

HAMBURG.—*Thomson-Houston system.*—Length, 21·5 km.; gradient, 5 in 100; 36 carriages.

THE UNITED KINGDOM.

1883. BLACKPOOL.—*Elwell-Parker* † *system.*—Length, 3·2 km. Gauge of 1·45 m., underground. 240 volts, 2 × 70 steam H.P. 8 or 9 carriages with 56 seats. In 1891, 156,800 car-kilometres were travelled. The cost per car-kilometre is ·66 of a franc. Worked by the Blackpool Corporation.

1883. BRIGHTON.—*Holroyd-Smith* ‡ *system.*—Length, 1·6 km. Gauge, ·826 m.; central rail, 150 volts. Gas motor. Worked by Magnus Volk.

1883. PORTRUSH, GIANT'S CAUSEWAY (IRELAND).—*Siemens and Halske system.*—Length, 12·8 km.; central rail, 250 volts 100 ampères. 2 turbines of 50 H.P. 1 self-motive car carrying 50 passengers and 3 wagonettes. Worked by the Giant's Causeway Electric Tramway Company.

1883. BESSBROOK-NEWRY (IRELAND).—*Hopkinson system.* Length, 5 km. Gauge 1 m.; elevated central rail, 250 volts. Turbine of 62 H.P. 1 self-motive passenger car drawing wagonettes. Worked by Bessbrook-Newry Tramway Company.

1890. BIRMINGHAM.—Length, 4·8 km. E.P.S. accumulators. 14 self-motive carriages of 15 H.P. 2 motors of 100 steam H.P.; 2 dynamos, 120 volts 500 ampères. Worked by the Birmingham Central Tramway Company.

1891. LEEDS.—*Thomson-Houston system.*—Length, 9 km. 1 motor of 200 H.P.; 2 dynamos of 62 kw. 7 self-motive cars; 2 drawn. Gradient 5 in 100. Gauge, 1·455 m. 2 motors of 15 H.P., 300 volts. Worked by the Roundhay Electric Tramway Company.

1891. BRADFORD.—Length, 3 km. Reckenzaun accumulator-motors. Gauge, 1·219 m. 1 car with 36 seats. (Experimental line now abandoned.)

1891. CARSTAIRS.—*Anderson-Munro system.*—Length, 2 km. Worked by J. Monteith, Esq.

1891. CROYDON.—Length, 5·2 km. Accumulators. (Experimental line now abandoned.)

1891. GUERNSEY.—*Siemens and Halske system.*—Length, 4·4 km. Overhead line. 2 carriages. Worked by the Guernsey Railway Company.

1892. WALSALL, WEDNESBURY, BLOXWICH AND DARLESTON. Length, 12 km. Overhead line; underground feeders. First application of the trolley in England. 330 volts 275 ampères. 3 steam motors of 125 H.P. 3 dynamos of 90 kw. 16 carriages constructed to carry 40 passengers each and containing 2 motors of 15 H.P. Worked by the South Staffordshire Tramway Company. Installed by the Electric Construction Corporation.

1892. LONDON.—*Hopkinson system.*—King William Street to Stockwell. Length, 5·2 km.; gradient 3·3 in 100. Central rail, 500 volts, 400 ampères. 3 × 400 steam H.P. 1 locomotive with 2 motors to 3 cars of 7 tons, running every 6 minutes. Worked by the City and South London Railway Company.

1892. RYDE (ISLE OF WIGHT).—*Siemens system.*—Length, 1·2 km.; central rail, 120 volts 60 ampères. Gas motor of 12 H.P. 1 carriage holding 30 passengers. Worked by a local company.

1892. SOUTHEND PIER.—*Crompton system.*—Length, ·4 of a kilometre; central rail. Worked by a local company.

1893. LIVERPOOL.—*Hopkinson system.*—Length, 10 km.; central rail, 500 volts. 4 dynamos of 250 kw.; 4 motors of 450 H.P. Each train consists of 2 self-motive carriages, containing 56 seats. Worked by the Electric Construction Corporation.

1893. COVENTRY.—*Thomson-Houston system.*—7 carriages; 2 motors of 15 H.P. and 1 carriage; with 2 motors of 25 H.P. (In course of construction.)

AUSTRIA-HUNGARY.

1883. MÖDLING-VIENNA.—*Siemens and Halske system.*—Length, 4·3 km. Gauge, 1 metre R. = 30. Overhead line, 500 volts, 30 ampères, 185 steam horse-power. 8 self-motive carriages. Worked by K. k. priv. Südbahn-Gesellschaft zu Wien.

1883. BUDAPEST.—*Siemens and Halske system.*—Length, 15·5 km., now on service, 38·6 km. contemplated. Underground line 300 volts. 3 motors of 100 horse-power, and 3 of 200 horse-power. 42 self-motive carriages during the week and 60 on Sunday. Worked by the Budapester Electr. Stadtbahn Actien Gesellschaft.

BADEN-VÖSLAU.—*Schuckert system.*—Length, 5 km. Worked by Franz Fischer of Vienna.

BELGIUM.

BRUSSELS.—*Thomson-Houston system.*—*Brussels Tramways*, 5·5 km.; gradient, 6 in 100. 23 carriages. In course of construction. *Neighbouring tramways*, 9·7 km.; gradient 4 in 100. 12 carriages.

LIEGE. *Thomson-Houston system.* (In course of construction.)

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* *L'Industrie Electrique.*

† Should not this be Holroyd-Smith system?

‡ Should not this be Volk system?

SPAIN.

1891. BILBAO.—*Thomson-Houston system.*—Length, 14 km.; gradient 7 in 100. 2 dynamos of 100 kw. 12 self-motive carriages, with 2 motors of 25 horse-power. Gauge, 1·57 metres. 2 compound McIntoch and Seymour machines of 140 horse-power.

FRANCE.

1890. CLERMONT-FERRAND TO ROYAT.—*Thury system.*—Length, 7·33 km. Overhead line, 500 volts, 210 ampères. 1 motor of 150 horse-power and of 400 horse-power. 20 self-motive carriages. Worked by a joint-stock company.

1891. SALEVE.—*Thury system.*—Abt rack system. Overhead line, 600 volts, 275 ampères. 3 turbines of 250 horse-power. 12 carriages, with 40 seats, and 4 goods vans. Worked by a Geneva company.

1892. MARSEILLES.—*Oerlikon system.*—Length, 6 km.; gradient of 7 in 100. Overhead line, 550 volts, 3 motors of 100 horse-power, 3 dynamos of 66 kw. Worked by the Compagnie Générale Française des Tramways.

1892. PARIS.—*Madeline-Saint-Denis.*—Length, 8·4 km. Laurent-Cély accumulators. Manchester motors. 16 self-motive carriages with 52 seats, 4 motors of 125 horse-power. Worked at the expense of the Société des Tramways de Paris et du departement de la Seine.

1893. PARIS.—*Opéra Saint-Denis.*—*Same system.*—Length, 10 km. This line has gradients of 3·6 in 100 in the Rue Maubeuge. The carriages, with the outside seats weigh 12 tons empty, and the accumulators, 4,000 kg.

1893. LYONS—SAINT-JUST TO SAINTE-FOY.—Length, 3 km. Oulins. *Thomson-Houston system.*—10 carriages. 2 motors of 15 horse-power. Gradient 5 in 100. (In contemplation.)

ROUBAIX TO TOURCOING.—*Thomson-Houston system.*—Length, 4·15 km. (In contemplation.)

MOUVEAUX TO WATRELOOS.—*Thomson-Houston system.* Length, 6·27 km. (In contemplation.)

System of the town of Havre.—*Thomson-Houston system.*—Length, 19 km. 40 carriages. 3 dynamos of 200 kw.

HAVRE-MONTIVILLIERS.—*Thomson-Houston system.*—Length, 19 km.

ETAPLES TO TOUQUET.—*Thomson-Houston system.*—(In contemplation.)

BORDEAUX.—*Thomson-Houston system.*—BOUSCAT TO VIGEAN.—Length, 5 km. 6 carriages drawn. 2 dynamos of 100 kw. 2 steam motors of 150 horse-power. 500 volts. 1 motor of 15 horse-power per carriage. Gauge, 1 metre. (In course of construction.)

ITALY.

1890. FLORENCE TO FIESOLE.—*Sprague and Thomson-Houston system.*—Length, 7·5 km.; gradient, 8 in 100. Gauge of 1·45 m., R. = 18. Overhead line, 500 volts, 110 ampères. 3 steam motors of 80 horse-power. 3 dynamos of 75 kw. 2 T. H. motors of 15 horse-power.

1892 GENOA.—*Thury system.*—Length, 3 km.; 525 volts. 2 motors of 150 H.P., 4 self-motive carriages with 2 wagonettes. Worked by Messrs. Bucher & Durrer.

1893. GENOA.—*Sprague system.*—Length, 4 km. (In course of construction.)

1893. MILAN.—*Thomson-Houston system.*—Length, 5·4 km.; gradient, 4 in 100. Gauge of 1·445 m. 10 carriages with 1 motor each; 2 dynamos of 100 kw. Tosi motors. Worked under the direction of Messrs. Niso, Caneva, and Civita.

THE NETHERLANDS.

LA HAYE-SCHEVENINGEN.—Julien accumulators.

RUSSIA.

1893. MURICH-OSTRAU.—Length, 7 km. (In course of construction.)

1893. KIEW.—*Sprague system.*—Length, 7·5 km. In course of construction by the Allgemeine Elektricitäts-Gesellschaft, of Berlin.

NORWAY.

1893. CHRISTIANIA.—*Sprague system.*—Length, 7·5 km., 22 carriages. (In course of construction.)

SWITZERLAND.

1887. VEVEY-MONTREUX-CHILLON (Canton of Vaud).—Length, 10·5 km., gradient, 2·9 in 100. Gauge, 1·45 m., R. = 40. Double overhead line, 350 to 400 volts = 19 self-motive carriages. Constructed and worked by the Vevey-Montreux Company.

1891. GUTSCH-MURREN (CANTON OF BERNE).—*Sprague system.*—Length, 4·3 km.; gradient 5 in 100. Vignole rails. 1 overhead line, returning by the rails. E. = 600 volts, I. = 150 ampères. Contact wire of silicious bronze 6 mm. in diameter, supply wires 8 mm. Esher-Wyss turbine coupled directly with Brown dynamo of 700 t/m. 3 electric locomotives, 2 large passenger cars and 2 goods vans. Constructed by Oerlikon.

1891. SISSACH-GELTERKINDEN (BALE).—*Sprague system.*—Length, 3·250 km; 1 overhead wire 6 mm., returning by the rails. Oerlikon dynamos of 40 kw., 600 volts, 47 ampères. Jonval turbine of 40 H.P., 6·75 metres, fall of 600 litres per second. 4 passenger cars, 2 goods vans. 1 electric locomotive and 1 steam locomotive in case of accident. Constructed by Pimpin and Herzog, at Berne.

1892. ORBE-CHAVORNAY (CANTON OF VAUD).—Length, 4 km. 1 overhead wire, returning by the rails. Thury dynamos, 500 to 600 volts, 66 to 80 ampères.

1892. SAN SALVATORE (TESSIN).—Abt funicular machine Turbine 60 H.P. to 7 km., transport of energy, 1,800 volts.

1892. OERLIKON WORKS (Canton of Zurich).—*Sprague system.*—Length, 1 km., 500 volts, 60 ampères.

1893. STANSSTAD-STANS (Canton of Unterwald).—Length, 3 km., 1 overhead wire, returning by the rails. Thury dynamos, 500 volts, 55 ampères. Turbine of 120 H.P. at 5 km. Constructed by Bucher & Durrer.

1893. ZURICH.—2 lines of 1·370 km., and 750 m. 1 overhead wire, returning by the rails; 550 volts, 120 ampères. Constructed by Oerlikon. Trials by accumulators on several lines at Zurich by the Oerlikon Works.

MODERN GAS AND OIL ENGINES.

ATTENTION is now drawn to a use for oil engines which seems especially suitable for them, viz., in agricultural work. For threshing and ploughing purposes an oil engine is perfectly fitted in every way, and dispenses with the danger of a boiler. The Hornsby-Akroyd is such an engine, built by R. Hornsby & Sons, of Grantham, to work on an Otto cycle, and fitted with a vaporiser, which once started, is kept hot by the explosions within it. Oil of ·8 to ·88 S.G. is used; it flashes at 200° to 250° F., and regulation is effected by allowing some of the oil pumped to the vaporiser to pass back to the tank through a small valve operated by a governor.

In the agricultural portable type of this engine the water tank takes the place of the boiler of the steam engine, an oil tank occupies the firebox space, and a silencing chamber takes the funnel's position. The familiar appearance of the agricultural engine is preserved: this will suit the farmers, and, of course, avoid frightening the *coos*, which have become hardened to the familiar steam engine.

A similar engine is made by Robey & Co., of Lincoln, and oil engines are made by Van Duzen & Co., of Cincinnati, and by the Sintz Company, of Grand Rapids; this latter having a closed crank case and an explosion every revolution, the piston front acting as a compression pump.

The Forward gas engine, by Barker Co., of Birmingham, is notable for having a starting device which causes the engine to run as a Lenoir engine for a time, when a blow-off is closed and a cam set to exhaust every revolution, and the charge is fired then by an incandescent tube. The Trent gas engine, of Nottingham, explodes every revolution, has a cylinder of two different diameters with a double-ended piston, and has a special explosion chamber. It has been built of 100 horse-power. The effect of an explosion every revolution is secured in the Hicks's gas engine, of Cleveland, Ohio, by having two cylinders on the Otto cycle exploding alternately, whereby a double power is got without extra stress in the crank-shaft, and a smaller fly-wheel can be used.

Stephenson & Co., of Newcastle, build the "Rocket" petroleum engine on Kaselowsky's patent.

It works on the common four-stroke cycle, and is governed by cutting off the supply of explosive vapour, the governor also acting at the same time to relieve the compression in the cylinder when an explosion is not wanted. These various oil engines would require too much space to fully describe, and we can only indicate a few of the points. The illustrations of oil and similar engines rather convey an impression of what is customarily termed the "rattle trap" in construction. It must not be forgotten, however, that all this complexity of excrescence upon and about the working cylinder represents the boiler, feed pump, flues, chimney, feed heater and stoking man or machine, and by so much is perhaps excusable. As electricity displaces gas, the field for the oil engine will become wider. It is, however, but a gas engine, and has all the faults of this in regard to irregularity of running.

THE LIFE OF EDISON.

Cassier's Magazine, in a series of articles by Messrs. A. and W. K. L. Dickson, continues to extol the life and inventions of Edison. This series has been in progress during the past eight months, but the end seems as far off as ever. Each number, in its own way, is a distinct ovation, and each seems more likely "to be continued in our next," than the last.

We are generally prepared, in the month of June, to make some allowance for excesses of fine feeling, as Byron did; but even in June it requires a specially wrought individual to bestow a deep enthusiasm upon the glow from an electric lamp. The June number of *Cassier's* begins thus: "The breathings of Marsyas's flute which trenched upon the golden harmonies of Phœbus Apollo, and the glowing fabric of Arachne which outvied the textile intricacies of Pallas Athene; the spell of Arion which smoothed the wrinkled brow of ancient Oceanus, and the magic strains of Orpheus, at which the basaltic gates of Hades rolled suddenly back on their adamantine hinges, all these endangered the attributes of Olympus, and the gods themselves became ashamed of their earthly children. But the majesty of heaven entrenched itself in the mysterious and deadly arsenal of the skies, in the thunder-bolts of Zeus, the steel-blue Ægis of the sheet lightning, the forked spears and chains of deadly fire."

By a more or less natural sequence this florid language leads to the contemplation of the voltaic arc: "the progress of electric sparks between two separated carbon points," and is followed by a really interesting account of the great hunt after a bamboo filament.

The filament expedition was entrusted by Edison to Mr. Frank McGowan. It was a long route along the Amazon and Napo rivers, and involved unusual danger. No fewer than eighty varieties of bamboo, and 3,000 kinds of vegetable fibre, were tested successively. The bamboo secured was of a superior quality, but was finally abandoned by Edison for a Japanese variety. The journey was performed partly in canoes and partly on foot, amid the strikes of Indians and the depredations of tigers.

Curiously enough, although Mr. McGowan successfully carried out these expeditions, he mysteriously disappeared, suddenly and inexplicably, shortly after their completion. Some explain that the daring traveller must have succumbed to the ill-health which resulted from his many hardships, but the more general opinion is that he was spirited away by a certain lustrous-eyed senorita to the idyllic seclusion of some sweet Eden. *La belle dame, sans merci*, seems to have "spidered" him very successfully, this man of fibres, for the thread of his history is here lost for ever. Our explanation is that he has changed his name, he was always McGowan, and now he's McGone!

While Edison was giving his days and nights to filaments, phonographs, and megaphones, he probably did not trouble much about what people said of him. It would be interesting to know what he now thinks of his life and inventions, and in what regard he holds these many effusions upon his greatness. By us he has always been held to be of the plain speaking, clear thinking, hard working sort; with nothing necromantic, creepy, or gipsy-like in his composition. When, therefore, all the principalities and powers are invoked to sound the praises of his efforts we should not be surprised if he requested them, as far as he was concerned to "let him up, and send, for a spell, with the other foot."

The expedition sent to Ceylon and India for the purpose of finding a suitable bamboo for glow-lamp filaments, was conducted by Mr. Ricalton; he set out in February, 1888, and returned just twelve months afterwards, having searched from Cape Comorin to the Ganges, and then through the forests of the Himalayas to Assam, Burmah, Singapore, Hong-Kong and Japan. The bamboo of which Edison finally made filaments was that discovered by Mr. William Moore in northern Japan. Over $100,000 were expended by Edison upon this enterprise. In addition, there was an immense amount of work to be done in the perfection of the lamp itself, in the sealing-in of contact wires, in choosing the best shapes for globes and filaments, and in the matter of sockets. Summing up the labours of Edison in this direction, his biographers say: "at no time has he ever advanced a claim of original discovery in connection with the electric light, but he does claim, and with undeniable justice, that in his hand the immature and scattered principles of his predecessors were perfected and welded into one symmetric whole. In his hands the incandescent electric light was disinterred from the fruitless seclusion of the laboratory, and transferred to the plane of practical utility."

ELECTRICAL ENGINEERING AT THE WORLD'S FAIR.

[FROM OUR SPECIAL COMMISSIONER.]

VI.

STORAGE BATTERIES.

The Americans have not yet made much use of storage batteries. These batteries do not lend themselves readily to the rough and tumble style of doing work common in America. A motor or dynamo, however badly designed, will work somehow, and stand a deal of rough handling, but storage batteries require intelligent care—a rather scarce commodity—hence they have not met with much success. The display of storage batteries is very small.

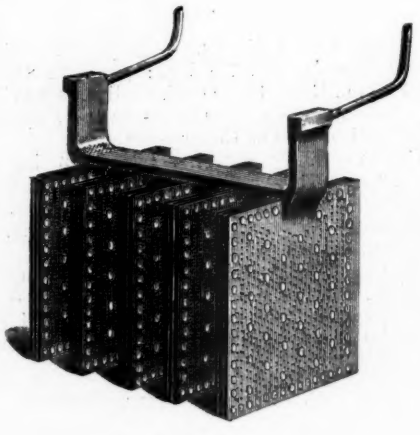


FIG. 1.

The Consolidated Company show cells very much the same as the E.P.S. Company of London cell. Between the plates a hard rubber separator is placed; this separator consists of a sheet corrugated and perforated with holes. These sheets are a little larger than the lead plates; they make excellent separators but must largely increase the internal resistance of the cells as the total area of the perforations is small.

The Epstein battery is shown on a stand behind the General Electric Company of London. The cells shown are same as those used in London.

The Union Electric Company show two forms of cells of American make; they are the best cells shown, and are of two kinds—one a lead zinc cell, the other a lead-lead cell. The lead in both is the positive electrode and is formed on the Planté system; it is made of a number of thin sheets of lead enclosed between two stout outer sheets; these are all perforated at once, after being secured together by lead rivets, as in fig. 1.

The transverse holes, which remain open, give free access of current and fluid to the interior of the plate. The working surface thus obtained is much greater than the outer flat sides would afford; no peroxide can drop out, and the plate, however thick, is discharged uniformly throughout.

Hard rubber separators are used, serving both as supports and to preserve the space between electrodes, which is greater than in other storage cells. (See fig. 2.)

FIG. 2.

The positive plates are a little over 6 inches square. Each plate will yield 50 ampère-hours under a moderate rate of discharge.

The positive plate of the K (fig. 3) cell is exactly similar, but is about 6 inches by 2¼ inches instead of being square, and has a capacity of 15 ampère hours.

The construction of the negative pole or plate differs from the usual methods even more widely than that of the positive plate.

It is made of an amalgam of zinc and mercury, deposited electrolytically upon a copper plate.

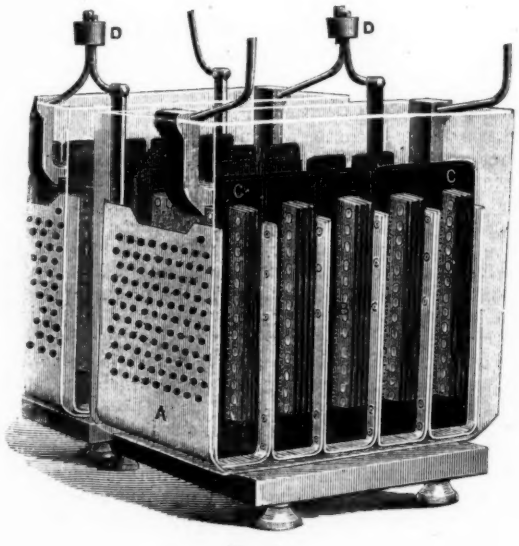


FIG. 3.

Zinc gives a higher electromotive force than the spongy lead usually employed, and but little is required. It is partly dissolved during the discharge of a cell and re-deposited upon the copper plate by the charging current, so that there is no loss. The copper support gives permanence and high conductivity to what would be otherwise a perishable plate, while a small amount of mercury suffices to prevent local action, as it spreads by capillary action over the whole surface. The copper sheets are of No. 22 gauge, but the deposited zinc amalgam, with which they are coated, does not alter their form enough to show very noticeably, although, of course, making them somewhat thicker and rougher than they would be otherwise. Each copper sheet has a number of large perforations through it, giving a better hold to the soft amalgam, and it is long enough to bend into a U form, so as to come opposite to both sides of the lead plate. These sheet copper U's are riveted together in numbers corresponding to the lead plates. (See fig. 3.)

The method of connecting the cells is the most simple and effective which has yet been devised.

The connecting wires are of copper, solidly coated with lead. The clamp is an oval collar of hard lead alloy, slightly tapered in one direction to correspond with a key wedge of the same material, which is lightly rapped into place, or pressed in with pliers. The inner face of the wedge is hollowed to fit the wire, so that a considerable surface is driven firmly into contact. Rapping the collar downward, with a light, quick stroke, or the application of pliers to the small end of the key and the upper face of the collar, will loosen it in a moment. (See fig. 4.)

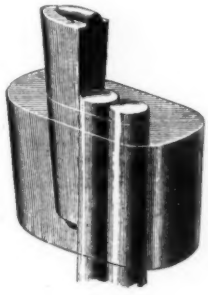


FIG. 4.

This connection exposes no brass or copper to the action of acid; has no hard rubber to break or screw to stick fast; it is made wholly of conductive and non-corrodible material, and has proved reliable under the most trying conditions.

The advantages which these cells will be seen to possess from this description are:—1. High potential (2·4 volts per cell); 2. Light weight; 3. Freedom from buckling, sulphating and short circuiting of the plates, and consequently 4. Durability and low cost of maintenance.

There is a small space about ⅛th inch wide between adjacent copper plates, into this space zinc plates are dropped, these plates are drawn upon in case of all the zinc being dissolved from the copper. This battery is the invention of Mr. Main.

The other storage battery shown by the Union Company is a Planté battery, both plates being lead and made as the lead plate already described.

The Union Company also show a dynamo in which both armature and field coils are fixed and only the pole pieces

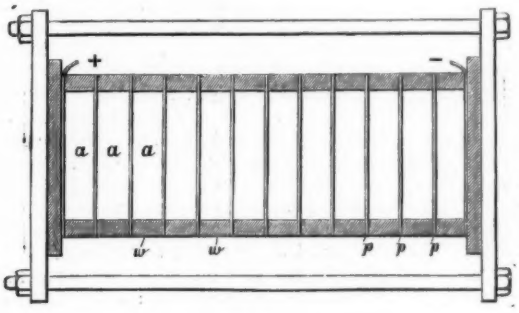


FIG. 5.

revolve. It seems to be a mistake to make it a continuous current machine with revolving brushes, it would make a much better alternator without any brushes whatever. The revolving brushes are a mistake.

O

There is one Russian exhibit in the Electricity Building, but, like the French exhibits, there does not seem to be any attendant, and no circulars, cards, or any means of obtaining information except by observation. The French exhibits are quite numerous, but not a single attendant can be found. In the Russian exhibit a storage battery is to be seen of a very primitive kind; it consists of a number of circular sheets of lead about one foot in diameter and one inch apart, P, P, P, in figure 5, separated by rings of wood, W, W, leaving spaces, *a*, *a*, for solution of acid, the whole is held together by bolts, the liquid is filled in through holes in the wood rings; at the Russian exhibit an electric lamp is shown which shall be described later on.

Among the French exhibits are shown two storage cells of the Planté make, in which the plates form concentric cylinders made up of thin lead deeply corrugated.

THE UTILISATION OF TOWN REFUSE FOR POWER PRODUCTION.

By THOMAS TOMLINSON, B.E., Assoc.M.Inst.C.E.

(*Continued from page* 145.)

Coming now to practically attained results: Mr. W. B. G. Bennett, Assoc. M.I.C.E., in a paper on "The Utilisation of Town Refuse, Sewage Disposal, and Electric Lighting at Southampton" (*Journal of the Association of Municipal and Sanitary Engineers*, Vol. xv.), gives, for a 6 cell Fryer destructor, the maximum burnt in 24 hours as 50 tons, and the minimum as 25 tons, and adds "this quantity (25 tons) has run an engine 31·5 I.H.P. for 24 hours." This gives:

30·0 I.H.P. hours per ton burnt.
7·5 I.H.P. continuously per cell burning 6 tons in 24 hours.
0·27 lbs. of water evaporated per lb. of refuse.
0·027 evaporative value compared to coal.

In giving these figures I assume that the I.H.P. hour was obtained for 20 lbs. of steam (so as to keep to that figure); but the real figure certainly exceeded this, and all the figures will be improved by so much in comparison with other figures based on measurements or estimates of evaporation, and taking the I.H.P. hour as the equivalent of 20 lbs. of water; but in dealing with small engines it must be remembered that this latter figure is too low. To avoid misunderstanding I shall, when I come to tabulate the results, distinguish between actual measured I.H.P. and calculated I.H.P. at 20 lbs. per I.H.P. The continuous I.H.P. per cell burning 6 tons in 24 hours is got by proportion from the actual I.H.P., 5¼ per cell burning 4⅛th tons.

It should be noted that Southampton, where these figures were obtained, is specially instanced by Prof. Forbes as having a typically bad arrangement for the utilisation of the heat. In his Cantor lectures already alluded to, he says, "In many places, take Southampton for example, as a notable case, the boilers are put in a place where they cannot benefit from the maximum heat." Whether they are worse placed than practical consideration necessitates, *i.e.*, further from the source of heat than is necessary, I cannot say.

On looking to the L.C.C. report, I find that Southampton collects and disposes of rubbish amounting to 6·1 cwts. per head per annum (population 65,325, rubbish 20,000 tons) of which it is noted that "part is burnt, part sold." Six cells at normal rate would dispose of about 12,000 tons, which would be under 4 cwts. per head per annum; but evidently the cells are at times worked at a higher rate than the normal 6 tons per 24 hours and at times lower.

The statement that the amount burnt varies from 25 to 50 tons per 24 hours should be noted; if this indicates a corresponding flux of supply, the utilisation of ashbin refuse as a power producer becomes complicated, unless the demand for power coincides exactly with the supply of refuse. Mr. C. Jones, M.I.C.E. (of Ealing), is of opinion that a considerable variation in the amount of the supply must be allowed for.

The indisputable fact established by Mr. Bennett's work is that the refuse of a population of 65,325 will certainly run a 31·5 I.H.P. engine all the year round. If this did not stand as an absolutely achieved result one could go lower. Since in the discussion on a paper by Mr. C. Jones (*Minutes Proc. of Municipal and Sanitary Engineers*, Vol. xiii.), Mr. Lemon (on the authority of Mr. Cartwright) states that 16 tons of refuse runs an 8 I.H.P. engine for 24 hours; this gives 12 I.H.P. hours per ton of refuse burnt: with so small an engine, this would mean about 24 I.H.P. hours, on a basis of 20 lbs. of water per I.H.P. Mr. Hewson, M.I.C.E. (Leeds), goes still lower: "Although we consumed 50 tons of refuse per day, we had no more than 16 or 17 actual H.P.," this gives 8 to 10 I.H.P. hours per ton of refuse burnt, with the same remark as to the meaning of this result reduced to the basis of 20 lbs. of water per I.H.P. hour. It would much facilitate comparison if all results were given in lbs. of water evaporated, since the steam consumption of an engine per indicated horse-power hour varies within such wide limits.

Mr. Hewson's figures were before the introduction of the steam jet.

We next come to Mr. Watson's experiment, an account of which is given in his paper already referred to: as this experiment is the first (and so far as I know the last) attempt to scientifically measure the actual evaporative value of ashbin refuse burned under practical conditions, I shall give Mr. Watson's own account of it:—

"The average temperature of the mattress chamber through which the hot gases pass on their way to the boiler was found to be 2019° F., the minimum being 1654° F., and the maximum 2346° F. The above results are confirmed by the melting of three pieces of cast-iron, of which the melting point was not less than 2010° F. in one of the fires.

"The temperature of the gases as they escaped from the boiler flues was also measured and found to be 855° F., but since the iron could only be hung in front of the opening to the large dust chamber where the gases must already have expanded and cooled considerably, it will be quite safe to assume that the temperature on leaving the boiler was not less than 900° F. The boiler is multitubular, 7 feet in diameter by 12 feet long, and is fed through a new Kennedy's patent water meter, which was used for measuring the water in the evaporative trials. The first trial extended over four hours on June 23rd, the boiler water gauge being marked, and the water brought back to the same level at the end of the test. The second trial was held the following day for six hours, and the average evaporation for the two trials was found to be 278 gallons per hour.

"The steam used by the steam jets was ascertained by means of a two hours' test, and was found to be equivalent to 150 gallons of water per hour.

"The boiler room being quite inadequate, it is fair to assume that with another boiler the gases could be reduced in temperature 200° lower or down to 700° F., while, at the same time, relieving the first boiler of its excess of output (which no doubt caused priming), and, therefore, the actual evaporative power may be put at 328 gallons per hour. Deducting the 150 gallons for the steam jets, we have 178 gallons, or 1,780 lbs. of steam at 70 lbs. pressure per square inch per hour available for use, which would be equivalent to 89 indicated horse-power from the six cells burning 1½ tons of refuse. That is about 15 indicated horse-power per cell, as against 32 indicated horse-power, which was found to be the theoretical amount.

"The Oldham plant was not laid out in such a manner as to insure the maximum steam raising capacity, and the author has no doubt at all that with certain improvements, a much better result may be obtained, and one much nearer to the theoretical amount, which was based upon a fair efficiency of the plant."

If we take the actual result obtained, we have:—

42·5 I.H.P. hours per ton burnt.
10·6 I.H.P. continuously per cell burning 6 tons in 24 hours.
0·38 lbs. of water evaporated per lb. refuse.
0·038 evaporative value compared to coal.

If we take the figures deduced by Mr. Watson, allowing for an extra evaporation of 50 gallons per hour with increased boiler capacity, the figures are:—

60·0 I.H.P. hours per ton burnt.
15·0 I.H.P. continuously per cell burning 6 tons in 24 hours.
0·54 lbs. of water evaporated per lb. refuse.
0·054 evaporative value compared to coal.

A comparison of the two sets of figures shows what a very large effect the assumption of the extra 500 lbs. of evaporation has upon the net available power: it would be a fair assumption to say that if a reduction in temperature from 2,000° F. to 900° F. evaporates 2,780 lbs. of water per hour, then a reduction from 2,000° F. to 700° F. would, in a suitable boiler, evaporate 3,280 lbs. of water per hour, provided the 2,780 lbs. was *true* evaporation. Mr. Watson, however, it will have been noticed, states "that the overrunning of the boiler no doubt caused priming"; to this extent, whatever it may be, then the second set of figures are overstated.

Referring to the L.C.C. report, I find that Oldham with a population of 136,469, collects 40,000 tons of rubbish, of which one-quarter is burnt and three-quarters tipped; this makes the average 6 cwt. per inhabitant per annum, of which 1·5 cwt. only is burned; it is reasonable to suppose that with tips available the most burnable only is burnt, so that a result obtained here is probably vitiated for purposes of generalisation as to the *complete* utilisation of ashbin refuse (at 4 cwt. per head per annum), by a process of selection. It may be added also that trials of four and six hours' duration are far too short to be an absolutely safe basis for wide generalisation as to evaporative value, especially with a material of such varying quality as ashbin refuse.

There is, then, the figure obtained at Birmingham, which is thus given in the L.C.C. report:—"At Birmingham, for instance, multitubular boilers are set in such a manner as to form the top of the furnace, and it is found in practice that 1 lb. of refuse will evaporate 1·79 lbs. of water, that is to say, that as a steam producer the refuse is about one-fifth the value of an equal weight of coal."

Here are the resulting figures:—

200 I.H.P. hours per ton burnt.
50 I.H.P. continuously per cell.
1·79 lbs. of water per lb. of refuse.
0·179 evaporative value compared to coal.

Assuming, as I have done throughout, that the destructor must be first as nearly perfect as possible as a destructor, then these figures are, on the authority of Prof. Forbes, useless for our purpose.

The fact that these figures exceed by 50 per cent. the theoretically possible figures first given, and also slightly exceed the second set, needs explaining. Unless the Birmingham destructors have a steam jet, the steam used by which is not deducted, unless, in fact, we are dealing with *gross* evaporation and not *net*, the figures show what a practical handicap to steam production (outside the furnace) the steam jet is, coupled with a position of the boiler not the best for utilising the heat generated. Both may be, probably are, practically necessary to an efficient destructor, but both are serious obstacles to the use of the destructors for power.

Mr. C. Jones has kindly placed at my disposal a copy of a valuable pamphlet (not yet public), containing answers received by him from engineers for 35 towns and districts in reply to certain questions, mostly directed towards the elucidation of the very important question as to the conditions for inoffensive burning of refuse, which must precede any utilisation for power production. Some of the questions and answers are of importance in connection with the subject of these articles.

For permission to make use of this pamphlet and also for much valuable information, freely given, I have much pleasure in tendering to Mr. Jones my grateful thanks.

The questions which bear directly upon the subject of these articles are seven (out of a total of thirty-one), and are as follows, the numbering of Mr. Jones's pamphlet being preserved:—

1. Name of town?
3. Population?
5. How do you dispose of town refuse?
6. How many tons or loads of refuse do you collect per day on an average?
11. How many cells?
12. Quantity of refuse destroyed per day per cell?
25. If the heat is utilised, what in your experience is each cell worth in I.H.P.?

Obviously only those towns or districts, the engineers of which reply to question 25 need, for the purposes of this article, be considered; these with the answers are in tabular form as follows:—

1.	3.	5.	6.	11.	12.	25
Batley	28,700	By destructor	45 loads ...	6 cells ...	3½ tons, about	5 H.P., about.
Birmingham ...	478,116	Part of ashes are screened and finer portion mixed with pan contents, and sold as manure. Remainder by destructor.	699 loads, about. (This includes ashes from pan closets, &c.)	37 „ ...	6 tons, about	Several tests show that 1 lb. of refuse will evaporate 1·79 lb. of water.
Blackburn ...	120,064	By destructor	130 tons ...	8 „ ...	6 tons ...	Eight cells + the cremator develop 45 I.H.P.
Bury	58,000	Part by destructor, part tipped	21,050 loads collected last year	4 „ ...	6½ „ ...	We work a 12 H.P. engine.
Ealing	25,000	Mixed with sewage sludge and destroyed in destructor.	21½ tons ...	7 „ and a cremator.	4½ „ ...	We work two 10-H.P. engines.
Hastings ...	58,000	By destructor	50 loads ...	4 cells ...	10 „ ...	Without cremator, 8½ H.P.; with cremator, at a temperature of 1,500° F., 17 H.P.
Heckmondwike	10,000	By destructor	10 loads ...	3 „ ...	3½ loads, about	12 H.P. engine for grinding clinkers.
Liverpool ...	517,951	By special steamer to sea, by canal barges to contractor, by destructor and waste lands	In 1891, 96,953 loads	12 cells and 12 more in course of construction	8 tons ...	No reliable test has been made, but should say about 5 H.P.
Southampton ...	65,325	By destructor	71 tons ...	6 cells ...	10 „ ...	According to condition of house refuse from 6 to 7 H.P.
Warrington ...	53,000	By destructor	250 tons weekly.	6 „ ..	7 „ ...	I should think about 10 H.P.

NOTE.—Ealing: With the addition of one cell, this plant is just about to be further utilised as auxiliary to the electric lighting, this development will be considered later.

SOME PHYSIOLOGICAL EXPERIMENTS WITH MAGNETS AT THE EDISON LABORATORY.

Read before the American Electro-Therapeutic Association by FREDERICK PETERSON, M.D., and A. E. KENNELLY.—From the *New York Medical Journal*.

MAGNETO-THERAPY has not gained such widespread application as has electricity in medicine, nor has it won to any great extent the confidence of the medical profession, for its effects are even more occult and less easily demonstrable than, for instance, the trophic influences of galvanism in poliomyelitis and progressive muscular atrophy. At the same time magneto-therapy has its adherents and earnest promulgators, to which any one will bear witness who has observed the transfer of singultus by a magnet from one girl to

another in Charcot's dramatic realms at the Salpêtrière, or who has at the Poliklinik watched Benedikt carefully adjust a 1 foot horse-shoe magnet to the hyperæsthetic spine of a hysterical girl. There are many lesser men than these who have implicit faith in that mysterious force, and there is no dearth of theories to explain the effects of magnetism upon the human organism. Prof. Benedikt has taught that erethetic forms of hysteria are better treated by the magnet than by electricity, hydro-therapy, or drugs. A magnet being applied to the sensitive vertebræ, without removal of the dress, the irritable patient soon becomes quiet and even quasi-paralysed. The magnet, therefore, "increases the resistance to conduction in the motor nerves." The muscles gradually relax, the respiration becomes sighing, consciousness slowly disappears; the resistance to conduction in motor nerves "could easily become absolute." The two poles have different effects. Sometimes one pole to a hyperæsthetic ovary fails to relieve pain, whereas a change of the poles causes its speedy disappearance. According to him, the magnet must be employed with due caution, since patients may be injured by it.

The status of magneto-therapy in America may be inferred from some quotations from the third edition of Robert Bartholow's *Medical Electricity*, 1887. Under the caption of "Physiological Effects of Magnet Applications," he says: "We know that a current circulates in a magnet. If a powerful horse-shoe magnet is brought near to the skin, opposite electricities are attracted to the poles and currents are induced. About the point of application, therefore, the skin will be acted on directly by the magnetic current and by an induced current. The production of physiological effects, which can be recognised is, therefore, merely a question of the magnetic strength."

He then quotes Dr. Vansant as assuming the body to be diamagnetic: "By applying north and south polarity to different parts, very extensive subjective impressions are experienced; they are of two classes—of heightened organic activity, and the opposite condition."

He then adds: "That impressions of a very decided kind are produced by the application of strong magnets is evident in the experience of Dr. Proust and Dr. Ballet, who continued a course of investigation begun by Charcot at Salpêtrière." They ascertained that magnets could not be applied with impunity, for, if applications were prolonged, pains were felt in the epigastrium and thorax, making respiration painful, digestion was disordered, and boulimia brought on. These results were so uniform that there seemed to be no doubt of their genuineness in the minds of the investigators.

Under the heading "Therapeutical Application of Magnets," Dr. Bartholow quotes Dr. Hammond as preferring a horse-shoe magnet, and advising that several of the same size be kept, so that by clamping them together more power can be obtained. The author adds: "Hammond insists on the necessity for the application of both poles in many cases, and therefore uses the horse-shoe magnet."

"Hammond has used magnets in nine cases of chorea, in two, 'complete cures being produced in a few minutes.'"

"In two cases of hemiplegia with hemianæsthesia, Hammond had very surprising results from the application of horse-shoe magnets, the sensibility returning immediately, and in one the hemiplegia was recovered from in a few hours."

The magnets used by physicians are generally those of a horse-shoe shape, varying from a few inches to a foot in length, and are the so-called permanent magnets. They exert a traction force equivalent to several ounces, and sometimes to from one to three or four pounds.

Electro-magnets can be made to sustain 200 lbs. to each square inch, or 14 kilogrammes to the square centimetre of active surface on either pole—that is to say, 28 kilogrammes to the square of active surface on either pole, if both poles are alike and share the load.

While rather sceptical as to the practical utility of the magnet in medicine, it occurred to us that if there was any truth whatever in the claims made by various distinguished authorities, if this interesting and undoubtedly powerful force had any effect at all upon living organic matter, we were in a position to demonstrate its physiological effects by means of magnets of enormous power placed at our disposal at the Edison laboratory, at Orange, N.J., through the kindness of Mr. Edison. Accordingly, we made experiments which we detail below, and which we consider as conclusive, in that they have been made with magnets of a strength possibly never before used for such purposes. The description of the magnet employed for preliminary experiments is as follows (fig. 1):—

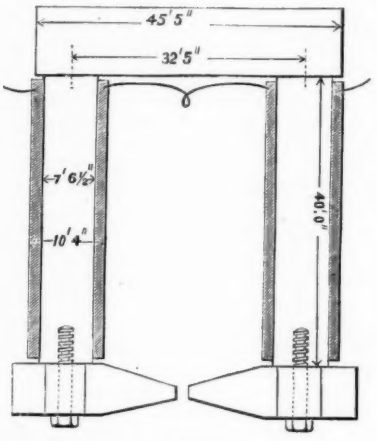


FIG. 1.—PLANE SECTION OF MAGNET THROUGH CORE AXES. NOT DRAWN TO SCALE.

It is of wrought-iron throughout, and its principal dimensions are represented in the sketch in centimetres. Roughly speaking, it is about a foot and a half wide by 2 feet long, and requires two men to lift it. The cross-section of the core is 49 square centimetres. The vertical angle of the cones is 36°, and the diameter of their plane faces 0·75 centimetres. There are 2,728 turns of wire on each limb, making 5,456 in all, and the current employed in exciting it was, approximately, 4·5 ampères. The pole faces were 1·20 centimetres apart, and it was between them that objects were placed for observation either with the naked eye or with the microscope. The intensity of the magnetic field between these poles was about 5,000 C.G.S. lines to the square centimetre.*

A drop of water placed on a glass slide in this field was visibly distorted in shape by the magnetic force.

The stage of the microscope was removed and wooden supports substituted. It was necessary to clamp the microscope down to the table to prevent its being drawn upward to the poles.

Nothing peculiar was noted in the effect upon iron in its finest powdered form—iron by hydrogen. It behaved just as iron filings would do, being strongly attracted. Iron by hydrogen placed in water was observed to be polarised by any ordinary magnet under the microscope.

Dry powdered hæmoglobin, exposed to the strong magnetic field above described, was not visibly affected by it. The iron it contains, however, is exceedingly minute (0·42 per cent.).

It was then thought possible that the iron in loose combination with fresh hæmoglobin in the blood corpuscles might be affected. Several experiments were made with both human and frog's blood. The blood, placed on slides and covered with a cover glass, was subjected to the strongest magnetic influence obtainable, and failed to show the feeblest traces of polarisation, movement or vibration.

It must be borne in mind that we were using an electro-magnet which we magnetised and demagnetised at will. First one would make the observations, the other experimenter attending to the current; then they were repeated and verified by the other on our changing places.

Living ciliated epithelium from the pharynx of a frog was now in like manner subjected to the magnet, and its behaviour watched under the microscope with a high power

* C.G.S., or "centimetre gramme-second," is the unit of measurement employed. The earth's magnetic field, measured horizontally, for instance, is estimated to be 0·18 C.G.S. line to the square centimetre near New York. Consequently our magnetic field was 27,778 times that of the earth's horizontal component, that aligns the compass needle.

objective, as the poles were magnetised and demagnetised by the making and breaking of the 120-volt current in the huge coils. The magnet had absolutely no effect upon the delicate ciliary movement, which kept on continuously, nor did it cause the slightest change or vibration in the cells themselves, suspended in the saline solution. After the magnetic observation a mild continuous electric current of 1 to 2 milliampères C.S. was carried through the microscopic field containing the moving ciliated cells, and this also had no effect whatever upon the movement.

Another frog was now taken and curarised, fastened upon a pasteboard frog-plate, and the web of the foot stretched in the usual manner to show the circulation of the blood in the capillaries under high power. As before, the object to be observed was placed between the poles of our magnet and the microscope focused upon it. The poles had to be separated somewhat farther to admit the large foot of the frog. With the clearance thus employed to allow of inserting the frog's foot the magnetic intensity was reduced from 5,000 C.G.S. lines to the square centimetre to 1,500 C.G.S. lines to the square centimetre. Repeated observation by both of us failed to demonstrate the feeblest influence of the magnet upon the blood cells or their movement in the vessels. At this point we determined to note the effect of the continuous current upon the circulation. A fine copper wire was placed upon one toe and another wrapped in moistened filtering paper above the ankle. The current strength in these trials never exceeded 2 milliampères, and generally varied between 1 and 2 milliampères.

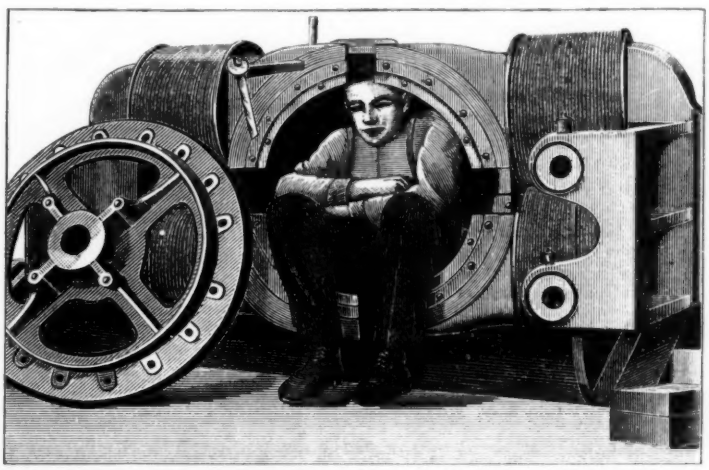


FIG. 2.—SHOWING FIELD MAGNETS IN WHOSE CYLINDRICAL CAVITY A DOG WAS PLACED. THE POWERFUL ATTRACTION OF BOLTS AND CHAINS IS DISTINCTLY NOTICEABLE. THE CIRCULAR BRASS COVER OR DOOR OF THE CAVITY IS SHOWN AT THE SIDE.

Whenever the current was made, the circulation in the foot under the microscope, which was about midway between the two electrodes (3 centimètres apart), gradually grew sluggish and finally ceased, complete stasis being produced, the blood vessels dilating. As soon as the current was cut off, gradually movement made itself manifest in the stagnant capillaries, and, becoming more and more lively, the circulation was in a few moments restored to its normal state. The effect was not due to the magnet, however, for it was observed with the current in the coils made or broken. This experiment was gone over frequently by each of us, so that the facts were fully verified.

It was now resolved to put Benedikt's statement to proof that magnetism "increases the resistance to conduction in motor nerves," thus causing paralysis. For this purpose a set of idle field magnets (fig. 2), which converge into a cylinder 2 feet in diameter and 7 inches deep, was employed. In this cylinder a small and lively young dog was placed and kept for five hours, and subjected during all that time to the influence of a magnetic field whose intensity was from 1,000 to 2,000 C.G.S. lines to the square centimetre. Fig. 2 is taken with a boy inside of the cavity in which the dog was kept for five hours. The magnets were excited while the photograph was being taken with the boy in it, as is evidenced by the position of the bolt above, and by the bar of iron, A, B, which not only supports its own weight in this horizontal position when touching the pole-piece, but also supports the wrench at its outer extremity. The chain, too, is magnetically influenced. There was no effect upon the boy. A clearer idea of the power of this magnet may be obtained when I say that heavy bolts, chisels, and pieces of iron in the immediate neighbourhood of this cylinder were drawn to it irresistibly, and that it required considerable muscular exertion to remove them. A heavy bolt placed slightly above the centre or axis of the cylinder remained suspended for a moment in the air, like Mohammed's coffin, so powerful were the opposing magnetic forces upon it compared with gravitation.

The five hours' exposure to this influence had not the slightest visible effect upon the animal, which was rather livelier in his capers on being set free than before, owing to his joy on being liberated from the cage.

Our next experiments were directed to studying the influence of magnetic fields on the human brain. The machine converts about 70 horse-power at full load. The armature and one journal were removed, leaving the space between the pole pieces free. This will be best understood by reference to the figures. Fig. 3 gives a view of the pole pieces into the cavity between which the head was to be inserted. This cavity is 35 centimetres (14 inches) in diameter, and 60 centimetres deep. The weight of this electro-magnet is over 5,000 lbs., and the intensity of the magnetic field produced within the polar cavity after removal of the armature, though not uniform, may be estimated at a mean of 2,500 C.G.S. lines to the square centimetre. A long board was placed upon the base plate leading into this polar cavity, and the subject experimented upon lay on his back upon the board, with his head and shoulders in the cavity between the poles, and exposed thus to the full influence of the magnetic field. There would be comparatively feeble residual magnetism, with no current in the coils. A switch, so nearly silent in action as to be inaudible to the subject, was arranged to

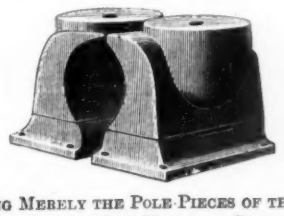


FIG. 3.—SHOWING MERELY THE POLE-PIECES OF THE DYNAMO, WITH ARMATURE REMOVED. THE HEAD WAS PLACED IN THE CAVITY BETWEEN THEM.

close and open the exciting current circuit through the field coils. On closing the switch, nearly the full magnetic intensity would be active, and permeating the head within practically one second (theoretically it takes an indefinitely long time to establish the full current and magnetism). Similarly, on opening the switch, almost the whole intensity would disappear in about one second.

Five men, ourselves among the number, were subjected to trial. One case described will describe all.

The subject lay back upon the board, and concentrated his

attention upon his sensations. His right wrist was extended, and was grasped by one observer, who took sphygmographic tracings of the pulse. A second observer placed a hand on his chest to observe any irregularity that might occur in respiration. A third observer, in view of these two, but unseen by the subject of the experiment, opened and closed the switch that excited and relaxed the field, signalling to the first two observers as he did so. The strong magnetic influence was, therefore, turned on or off at will, and without the knowledge of the subject. Several sphygmographic tracings were taken in each of our subjects, and in one the knee-jerk was tested continuously.

The sphygmographic tracings taken continuously during the *séance* show no change in regularity, in spite of the making and breaking of the enormous magnetic influence during its registration. The respirations were not changed in the least. The knee-jerk also presented absolutely no change. As to common sensations, there were none that could be attributed to the magnetic influence, and the subject could not discover when or whether the field had been excited. The testimony of all five subjects was alike. In one experiment the subject held a steel screw in his mouth, and was then able to tell when the poles were magnetised or demagnetised, but only by the pulling of the screw to one side or another, not by any peculiar sensation or taste.

Our last series of experiments was in connection with reversed magnetism.

A large coil of stout, cotton-covered copper wire, about 30 centimetres high and 25 centimetres internal diameter, composed of nearly 2,000 turns and weighing about 70 kilogrammes, was supported horizontally in such a manner that the head of the subject experimented upon could be freely introduced within the coil, and subjected to the electromagnetic field created there by passing a current through the wire. The resistance of the coil was 10 ohms, and its inductance 0·73 henry. An alternating electromotive force of 1,200 volts, making 140 cycles or 280 alternations to the second, was connected with this coil, the current supplied being 1·85 ampères. The magnetic field in the coil would thus be reversed 280 times to the second. Each of the authors acted as subjects in the experiments, permitting the 1,200-volt alternating current to be made and broken frequently in the huge magnetic coil surrounding his head. No effect whatever was experienced. The coil itself hummed with the current, and a strip of sheet-iron held in the cavity of the coil, but not touching it, vibrated perceptibly in the hand and gave a distinct, loud sound, which was determined to be middle C of the musical scale by means of Helmholtz resonators.

The authors conclude that the human organism is in no wise appreciably affected by the most powerful magnets known to modern science; that neither direct nor reversed magnetism exerts any perceptible influence upon the iron contained in the blood, upon the circulation, upon ciliary or protoplasmic movements, upon sensory or motor nerves, or upon the brain.

While our observations with reversed magnetism indicate that no appreciable influence is exerted upon the brain when subjected to 280 magnetic reversals to the second, we were unable to experimentally alter this frequency, and the possibility remains that some particular frequency or frequencies might affect the nervous system. We hope to decide this question, within a suitable range of frequency, at some future time.

The ordinary magnets used in medicine have a purely suggestive or psychic effect, and would in all probability be quite as useful if made of wood.

While we have demonstrated conclusively the above facts, we do not deny the possibility of there being invented, some day, magnets enormously more powerful than any yet known to us, which may produce effects upon the nervous system perceptible to some of the sensory organs; for magnetism is certainly a remarkable force, and we find it very difficult to understand why it seems to have no influence whatever upon the human body and its wonderfully delicate neuro-electric mechanism.

Stonehouse Town Hall to be lighted by Electricity.—The Local Board have resolved to spend £500 for supplying electric light to the Town Hall.

MAGNETIC VISCOSITY.

By J. HOPKINSON, D.Sc., F.R.S., E. WILSON, and F. LYDALL.*

In a recent paper determinations were given of curves showing the relation between the induction and the magnetising force, for rings of fine wire of soft iron and steel, through complete cycles with varying amplitudes of magnetising force, both with the ordinary ballistic method and with alternating currents of a frequency up to 125 complete periods per second. It was shown that if the induction was moderate in amount, for example, 3,000 or 4,000, the two curves closely agreed; but, if the induction was considerable, for example, 16,000, the curves differed somewhat, particularly in that part of the curve preceding the maximum induction. The difference was greater with steel than with soft iron.

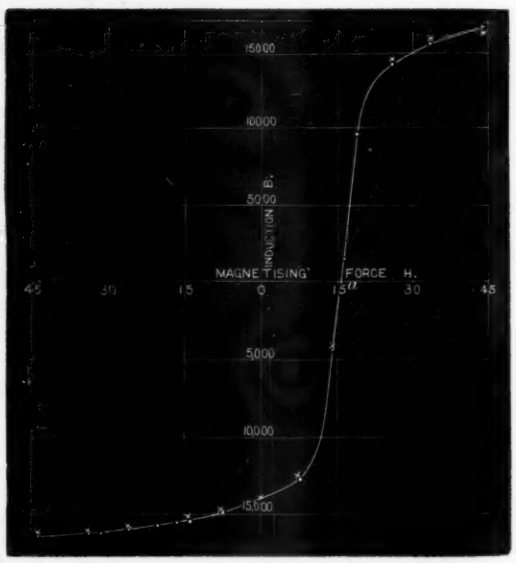
It was not then determined whether this difference was a true time effect, or was in some way due to the ballistic galvanometer. The present paper is addressed to settling this point.

The ring with which the experiments were made was of hard steel containing about 0·6 per cent. of carbon, in the form of wire $\frac{1}{10}$th inch diameter, varnished with shellac to ensure insulation. The ring was about 9 cm. diameter, with a sectional area of 1·08 sq. cm.; it was wound with 200 turns of primary copper wire for the magnetising current, and with 80 turns of fine secondary wire for use with the ballistic galvanometer.

In taking the kicks on the ballistic galvanometer the method adopted was as follows:—A steady current was passed through the primary, and then this current was suddenly reduced, thus allowing the magnetising force to drop to a determined amount and the kick on the ballistic galvanometer observed. A total reversal was then taken and the kick again observed; and finally the magnetising force was again brought up to its maximum in the opposite direction to that at starting.

In a second set of experiments it was arranged to vary the magnetising force from one maximum through zero to any desired point within the other maximum by one motion of a switch; which operation takes but a small fraction of a second to perform.

In the fig. the points marked × were obtained by the first method



the points marked ° being obtained by the second method, the two showing a close agreement. In each case the battery used had a potential difference of 108 volts, the periodic time of the ballastic needle being 10 seconds.

It was observed, when taking the hysteresis curve by the second method, that the sum of the inductions found by varying the magnetising force from one maximum to an intermediate point, and from that point to the other maximum, did not exactly equal the induction got by varying the magnetising force direct from one maximum to the other.

To investigate this with the ballistic galvanometer, the magnetising force was taken from one maximum through zero to the point, *a*, by one motion of a reversing switch handle, and the galvanometer circuit closed at known intervals of time *after* such change, the deflection being noted. This deflection does not represent an impulsive electromotive force, nor yet a constant current, but is caused by a current through the galvanometer diminishing in amount somewhat rapidly. It might arise from the comparatively slow rate at which the magnetising current changes, owing to the self-induction of the circuit, or it might arise from a finite time required to develop the induction corresponding to a given magnetising force. The former would be readily calculable if the ring had a definite self-induction; in our case it is approximately calculable, the results showing that the self-induction of the circuit can have nothing to do with the residual effects observed.

* Abstract of paper read before the Royal Society.

The experiments showed that an effect was produced upon the galvanometer needle, appreciable for some seconds, the effect being somewhat more marked with 4 than with 108 volts. But the whole amount was so small as to be less than 1 per cent. of the total change of induction; from which we infer that no material difference exists between curves of induction determined by the ballistic galvanometer and the inductions caused by magnetising forces operating for many seconds.

Effect of Tapping the Specimen.—Having taken the magnetising force from its maximum through zero to the point a, as before, the effect of tapping was marked, especially in the case of soft iron, when a kick, corresponding to an acquirement of 633 lines of induction per sq. cm., was observed.

Experiments on a hard steel wire ring were carried out with an alternator, the object being to ascertain if a time effect on magnetism exists. The ballistic curve (see fig.) has been taken as a standard with which to compare the respective hysteresis curves. In each case the maximum magnetising force has been made as nearly as possible to agree with that used when taking the ballistic curve.

The most noteworthy features in the curves obtained are that the curve with a frequency of 5 is very near the ballistic curve, if allowance is made for difference in the magnetising current, and that the curves with a frequency of 72 and 125 deviate very materially, particularly in the part of the curve somewhat preceding the maximum induction. Hence the time effect mainly develops with a greater frequency than 5 per second. Hence also it is inferred that this effect is a true time effect, not arising in any way from the ballistic galvanometer.

Experiments were also made upon chromium steel having the following composition:—0·71 per cent. carbon, 9·18 per cent. chromium, when annealed, and when hardened by raising to low yellow and plunging into cold water. The results show that the same time effect exists in this case, although it was not so marked as in the case of the hard steel.

We draw the following conclusions from these experiments:—(1.) As Professor Ewing has observed, after sudden change of magnetising force, the induction does not at once attain to its full value, but there is a slight increase going on for some seconds. (2.) The small difference between the ballistic curve of magnetisation with complete cycles and the curve determined with a considerable frequency, which has already been observed, is a true time effect, the difference being greater between a frequency of 72 per second and 5 per second than between 5 per second and the ballistic curve.

CORRESPONDENCE.

Relative Safety or Danger of Electric Light.

I have no desire to unduly continue this correspondence, which I think has now been pretty well thrashed out, with the exception of one or two points, but I feel I cannot close this discussion so far as I am personally concerned without thanking your modest correspondent, "C. S.," for his very interesting letter which contains some very useful information upon one or two points. However, I am sorry that "C. S." did not think fit to append his real name instead of signing under a *nom de plume*. I agree with "C. S.," subject to certain provisos, that electricity when applied for heating platinum wires or lighting small lamps, forms no part of the circuit; to this I would simply say, "Quite so" (provided the patient's body does not come in contact with the operator), in which case I think "C. S." must admit that a complete circuit would be formed, and in case of an uninterrupted flow of current, that a severe shock would be felt by the two, and it rests with "C. S." to uphold his views and prove to the contrary—a problem which I think he will have some difficulty in demonstrating to the readers of the ELECTRICAL REVIEW; and, although "C. S.'s" communication is interesting, he entirely overlooks the main issue, as others have done, and evades to answer the string of questions submitted by Dr. Waite, the originator of the subject matter under debate, whose communication appeared in the REVIEW of May 5th last, and it must not be forgotten in that communication Dr. Waite submitted many important questions for consideration, several of which have not been even touched upon or satisfactorily answered.

I may say I am quite ready to admit, with proper appliances, that alternating currents can be used for lighting small lamps; but, after all, this plan is both costly and wasteful, and as it covers such a very minute section of the electro-medical science, it may as well be buried for ever and not upheld as an argument in favour of adopting them, simply because the alternating current supply can be utilised by a few select physicians who have an exclusive home practice, and perhaps located in certain coveted districts where alternating current is obtainable; but this is not the class of operator we have to care or cater for, but must consider the wants of the thousands of provincial doctors who have to visit their patients sometimes miles away from home to administer to the wants of the million. Now, as "C. S." entirely agrees with my views on three points, which are the main points at issue, I think he must also give way on the fourth point, and at once candidly admit that for the average physician, resident in various parts of the country, there is nothing better, safer, or more practical than the utilisation of chemical currents, even for galvano-cautery work or for lighting laryngoscopes or other incandescent electric appliances for internal examinations, which operations can be so easily accomplished by the aid of any one of the portable storage batteries, many useful forms of which are now upon the market; there are also small primary cells and the modern dry batteries to fall back upon, any of which will suffice, and besides, such batteries can be enclosed in a neat mahogany box and carried under the seat of the doctor's carriage, and thus always ready for use in case of need, with but little trouble and no risk to patient or even expense to operator caused by melting the platinum points or spoiling his lamps as described by "C. S.," an annoyance which is likely to happen to those adopting high potential currents. I must also thank "C. S." for pointing out a slight error which inadvertently crept into my last letter which should read as follows, viz.:—*Cannot be economically* used, instead of simply "cannot," for on reference to my shorthand notes I find my clerk omitted the word *economically* in the copy sent for publication. This correction is therefore necessary in order to correctly and clearly explain my views on this particular point. I would also just say that I think "C. S." must have slightly stretched his imagination when he asserts that over 100 well-known surgeons have already installed and daily use the alternating currents for electro-surgical work. I was somewhat surprised at this assertion, and it may therefore interest this gentleman and others to know that I have caused enquiries to be made upon this point through channels upon which I can safely rely, and from information obtained, as far as I can learn up to date, that there are only 34 medical men throughout the United Kingdom who have as yet installed the electric light, very few of whom, so far, have ventured to play with high potential currents for either electro-medical or electro-surgical work, except for driving motors for working dental drills and ventilating purposes, for which, with care and suitable appliances if properly protected, these currents can be utilised to advantage, and, probably, for this class of work, in time may become a source of profit to central stations by assisting to increase the day loads.

In conclusion, I would say some alternating current systems have undoubtedly many advantages over others as a main supply, especially when distributed through sub-transformer stations by the three-wire system, and my advice to medical men is: by all means introduce electricity into your houses for both lighting, heating, ventilating, and other power purposes, but draw the line here and don't attempt to utilise such currents for electro-medical or electro-surgical operations, but stick to the old-fashioned and safe methods of generating the little current required for this work by continuing the chemical methods, and if they follow my advice and the suggestions given on these points, in the long run I feel sure that they will have no cause to regret having taken the candid advice of

Arthur T. Shippey.

August 8th, 1893.

The Return for Electrical Railways.

The above subject is treated in your issue of July 14th, 1893, Vol. xxxiii., No. 816, page 38.

Your treatment of this subject is timely, for it is one of great interest at the moment in this country.

The suggestion that the rail bonds should be soldered to the rails is quite impracticable, and if ever tried, certainly has never been used to any extent in America. From the beginning, the bonding has been either by the use of channel pins or by riveting "bonds" into the holes drilled in the rails. The "bond," as it is termed here, consisting of two Lake copper rivets, the copper bond wire itself being given two or three turns around the rivet under the head, the solder being used only to fasten the bond wire to the rivet.

Another form of bond is that in which the rivet has a

large square head formed on it, which is drilled to admit the bond wire through it, the two then being soldered together carefully. In either case the union between the rail and the bond is by means of riveting, and whichever form of bond is used, much care is necessary, to see that the soldered connection between the rivet and bond wire proper is not broken in the act of riveting.

Considerable use has also been made of bonds formed with the ends of "B B" galvanised iron wire wrapped around and soldered to soft Norway iron rivets.

The question as to the advisability of using copper instead of iron bonds is still a matter of dispute among those of wide experience in street railway work.

The objection to channel-pin work is, that in a very short time the channel-pins work loose through the continual pounding of the motor cars on the joints.

For small country roads, running not over five or six cars, simply bonding the rails will furnish in general a sufficiently satisfactory return, especially if artificial grounds are used whether in the form of old car wheels or sheets of copper or iron. When, however, city work is to be considered, especially if the number of cars is large, something more than mere bonding of the rails is required.

The use of two "supplementary wires," one under each rail, was largely used first by the Sprague Company. These wires were usually No. 6 B/S, laid one beneath each rail, the rail having a direct bearing contact upon the wire at each tie, the two "supplementary wires" being later bonded to each individual rail, besides being cross connected.

It was soon found a simpler matter to use a single "supplementary wire" of larger capacity, and that has been more generally used in recent times. The question, however, is not merely that of furnishing a good return for the current to the station using a less amount of copper than required for the outgoing feeders. The idea of using the earth as a return to save part of the copper, has proven in practice largely delusive.

In the cities it has been customary to ground the "supplementary wires" upon water pipes, usually without the permission of the city authorities. The results have been simply disastrous to such an extent that not only has the grounding to water pipes had to be abandoned, but resource has to be made to return feeders slowly for the purpose of preventing the current as far as possible from leaking into the ground, and thus producing endless expense and trouble with water pipes.

The best practice at present in the United States is simply to bond the rails usually with two, sometimes with three separate bonds at each joint, connect these bonds at intervals of, say, 500 feet, and to put in sufficient copper in return feeders to control the return current.

The use of continuous rail has not been sufficiently extensive as yet to warrant judgment as the expenses have its maintenance, but we do know that a rail made electrically continuous by triple bonds, if the work has been carefully done, can be maintained at a reasonable cost.

Further, when repairs are to be made, all the work is done simply at the joints which, when the streets are paved, is a matter of considerable consequence.

J. Stanford Brown.

New York, *July 29th*, 1893.

STEAM ENGINES AT THE WORLD'S FAIR.

MR. CLARK continues his description of the engines to be seen at Chicago in the current number of *Cassier's Magazine*, commencing with that of the General Electric Company, of New York and Boston, of the vertical direct acting triple expansion condensing type, similar to others made during the past two years, but with Corliss in place of piston valves. These, says Mr. Clark, are more suitable, the speed being 100 revolutions, though why a piston valve should be less suitable he does not explain, the fact being that there have been good piston valves made for the past 40 years, and they are still made, and have kept pace in details and improvements with any other valves, but somehow engineers seem curiously unaware of their existence. The cylinders of this engine are made 22½ inches, 33½ inches and 55⅝ inches diameter, with a stroke of 3 feet and a piston speed of 600, the ratio of expansion being 12½ for best efficiency and 7½ at maximum power, steam being carried at 160 pounds in the boiler.

It should be noted of this engine that the valves are in the cylinder ends, thus reducing clearance to a minimum. Though claimed as a novelty, we do not think this method of arranging the valves is without precedent. Still, it is sufficiently uncommon to warrant being specially noted, and yet when one comes to study the Corliss valve, and its enormous clearance volumes, it is hard to find a reason for the ordinary practice of placing the valves upon the barrel of the cylinder.

The dash pots are steam filled, and also placed in the cylinder covers, and the governor is very small and quick running. The design was intended for operating three-wire systems, the two dynamos being placed at the opposite ends of the crankshaft, the end bearings of which are water-jacketted—an arrangement rather suggestive of the accident which should not happen, and indicating insufficient bearing, or, perhaps, a concession to the overhung armatures. The normal output is 800 kilowatts or 5,333 ampères at 150 volts, rising to 920 kilowatts as maximum; but the economic load is 700 kilowatts only. It is expected that the calculated efficiency of 86 per cent. will be exceeded.

The armature weighs 39,000 pounds—a very fair flywheel in itself. The engine weighs 320,000 pounds in all, and the two dynamos 165,200 pounds, the outfit, as a whole, thus weighing 0·6 pounds per watt. In general appearance the engine is of marine type. The Corliss valves are worked by the wrist plate motion, to which Americans have so much clung, and which has, after all, been but little improved upon.

There are two compound tandem engines shown by the Stearns Manufacturing Company, of Erie, Pa., of the Woodbury variety, having each a double driving pulley, the smaller to run 200 revolutions for a horse-power of 375 to 500, according to load, with cylinders 15 inches and 25 inches by 20 inches stroke, the larger engine having cylinders 19 inches and 31 inches by 24 inches stroke for 165 revolutions at 600 to 800 horse-power. The piston speeds are thus 666 and 660 feet per minute, which appears to be about the usual speed for this class of short stroke engine in America, and as we believe they give every satisfaction in running, they appear to answer the charge, often made, that double acting engines cannot be run at high speeds with satisfaction.

The Woodbury engine has a balanced high pressure slide valve working between the cylinder face and a back plate. The back plate rests on the cylinder face through a pair of long taper wedges which can be drawn to and fro by a fine screw, that can be adjusted to give the back plate sufficient contact upon the valve to prevent steam passing, and yet keep off the steam load. The adjustment is made inside the valve chest and cannot be meddled with; means are also taken to secure an even temperature throughout the valve and chest. Though only *adjustable* inside the chest, there is an outside lever to raise the balance plate clear of the valve and let it back again as far as the adjustment inside will permit. This is merely for the sake of separating the faces after a stoppage, these being liable to stick. It strikes us that all this cumbersome complication of balanced slide valves is out of date. We do not condemn slide valves; they are well enough in small engines and easily made, but when thus balanced demand a care in making and in attention which must exceed the cost of a good piston valve. The danger of water in the cylinder is not serious in the Woodbury valve, for the back plate will lift under water pressure beneath. All the moving parts of both cylinders can be drawn back through the low pressure or rear cylinder without moving the cylinders, so says Mr. Clark, but the engraving shows that this is not the case unless the high pressure piston be left behind in its cylinder.

The Ball engine, 18 inches and 36 inches by 18 inches, cross compound type, is claimed to be the smallest engine for its bulk in the Fair, being intended to develop as much as 500 horse-power at 120 pounds pressure, running 200 to 250 revolutions and condensing. This is a horizontal engine with opposite cranks, the cylinders being kept as close as possible in order to reap all the benefit possible from the opposite cranks balancing, and reduce the

horizontal vibration which want of actual coincidence of the line of movement must set up.

The valve of the Ball engine is peculiar. There are two port faces on the cylinder, and the valve works between these, being really two valves placed back to back, one fitting into a recess in the back of the other, with the joint made tight by rings. Steam enters between the two valves and passes to both sets of ports, from which it afterwards exhausts outside the valves into the chest and away.

The Erie City Ironworks show engines of the Tangye frame variety with Richardson balanced valve.

Galloways, of Manchester, are the only exhibitors of a rope driving engine. This gives prominence to the superposed compound they are showing with their barring engine and parabolic governor.

We do not agree with Mr. Clark, however, in claiming rope driving as having originated in Crewe, where Mr. Ramsbottom used it for crane work, the ropes being of cotton, $\frac{5}{8}$ inch diameter, for we believe that ropes were used long prior to that date, under the name of rim bands, in self-acting mules. Indeed, driving by circular bands from $\frac{1}{16}$ inch diameter upward, has long been a recognised thing in textile mills, main driving merely being its larger evolution. Messrs Galloway are to be congratulated on the unique position in which they find themselves at Chicago, which only shows how poorly represented English engineering must be that no other rope geared engine is there. The barring engine, too, seems to draw attention, though in England no large mill engine is now put in without this useful little aid. Messrs. Galloway's is of the kind where the barring pinion is spun out of gear along helical feathers as soon as the large engine overruns the barring engine. Mr. Clark rightly refers to the great safety of ropes against breakdown, a rope when becoming weak beginning to show signs of disintegration, and being easily and quickly removed and replaced. He gives the cost of rope gearing as less than half that of belting and flat pulleys, a statement which is, we think, too favourable for ropes. We are promised a continuation of the descriptions, which, so far, have not included much of special novelty.

THE MIGRATION OF THE IONS.

FOR almost a century the passage of an electric current through an electrolyte has been attributed to direct transportation of the electricity by the ions resulting from the decomposition brought about by the current. The changes and improvements imparted to this, the crude theory of Grotthuss, by Williamson and Clausius, and more recently by Svanté Arrhenius, have not altered this explanation. The hypothesis of Arrhenius is almost of a startling character, and has met with the most persistent opposition, but in spite of severe attacks it has, so far, maintained its position. It is distinctly in its favour that the reasoning in a paper by G. F. Stradling (read at the stated meeting of the Electrical Section of the Franklin Institute, March 28th) on the migration of the ions might as well be based upon this hypothesis, as upon the older theory of Grotthuss.

In this paper the older theory is employed, since, on account of its simplicity, it lends itself more readily to explanation. Taking the well-known case of the electrolysis of dilute sulphuric acid, the author argues that since the two ions, the H and the SO_4, are different in nature, and will experience different resistances in the passage through the liquid, it follows that their velocities of migration will be different. So much for the antecedent probabilities of the case. In order to put this reasoning to the test, it is necessary to deduce the results that must follow were the velocities the same, and others which must follow, if they are different, and then by experiment to determine which deductions are supported by facts.

By means of diagrams, Mr. Stradling exhibits the distribution of anions and kathions before and after the current has passed, and argues that the velocities of the two ions must be different. He points out that the determination of the amount of the ions present in the liquid on each side of an imaginary partition can be made by chemical analysis, and thus the tenability of the supposition of equal velocities be examined. The results of Hittorf (*vide Poggendorff's Annalen*, lxxxix., xcviii., ciii., civ. and cvi.), who succeeded in doing this, are quoted, and show a remarkable agreement with each other.

For 20 years after the publication of Hittorf's researches upon the relative velocities of the ions, no one made any use of them for determining the absolute velocities. This was left for Kohlrausch to accomplish (*Wiedemann's Annalen*, vi., s. 160).

Mr. Stradling points out that from Hittorf we get the ratios of the velocities, and from Kohlrausch their sum, and from the two relations the absolute value of the velocities are readily obtained. In conclusion, he refers to Oliver Lodge's observation of the velocity of the passage of hydrogen, which closely agrees with that calculalated by Kohlrausch, and to Whetham's experiments on the velocity of certain ions (*vide Proc. Roy. Soc.*, November, 1892). He shows, by a comparison of observations with calculations, that they lead to almost identical conclusions respecting the absolute velocities of the ions, and concludes, therefore, that it is safe to assume that the suppositions which underlie the calculated results are in the main correct.

NOTES.

An Elevated Telegraph Line.—The line of telegraph in Cashmir, between Srinagar and Gilgit, reaches an altitude of 12,000 feet at the summit of the passage of Tragbal. It is probably the most elevated telegraph line in the world.

The Life of Incandescence Lamps.—As the results of a large number of experiments made by the firm of Siemens and Halske, of Berlin, the following is shown to be the duration of 16-candle-power incandescence lamps :—

Lamps of	Duration.
1·5 watts per candle	45 hours.
2·0 „ „	200 „
2·5 „ „	450 „
3·0 „ „	1,000 „
3·5 „ „	1,000 „

The Indian Telegraph Department.—During the years 1891-92, the Indian Telegraph system has been increased by 1,560 miles of line, and 6,680 miles of wire. The total lengths of line and wire, up to 1892, have reached 38,850 and 120,850 miles respectively. Amongst the construction work has been the erection of a wire between Golaghat and Ganhati, a distance of 446 miles, and a wire between Golaghat and Manipur, a distance of 165 miles. A wire has also been erected between Calcutta and Madras, by the east coast, a distance of 1,260 miles. The total number of telegrams dealt with was 2,601,241, whilst in the years 1882-83 the number was only 1,097,011. The total receipts were £707,400, and the total expenditure £460,200. The total amount expended since the introduction of the telegraph in 1851, represents a capital of £4,960,000.

A Difference between Electrolytes and Non-Electrolytes.—Mr. S. U. Pickering has pointed out that there is a general tendency for the molecular depression in the freezing point, produced when substances are dissolved in solutions, to diminish considerably, in the case of non-electrolytes, as the strength of the solution increases in contradistinction to electrolytes in which, with the exception of very weak solutions, the depression increases with the strength. In the *Berichte*, xxiv., 3,317 and 3,334, he notices several partial or apparent exceptions to this rule, at least, so far as it concerns electrolytes, but in these cases the increase, instead of decrease, noticed, is confined to comparatively weak solutions, and in several instances is followed by a decrease. In a more recent paper he lays stress upon the importance of noticing that electrolytes differ from non-electrolytes in giving abnormally large depressions, not only in very weak solution, when dissociation is supposed to be the cause, but also, and even to a greater degree, in strong solutions where electrolytic dissociation cannot be assigned as the cause.

The Azores Cable.—The steamer *Seine*, which has been chartered to lay the new cable between Portugal and the Azores, left Lisbon the end of last week. Previous to her departure, the vessel was visited by several of the Cabinet Ministers.

Peterborough Tradesmen want the Light.—The Town Council are not pushing forward with the electric lighting question rapidly enough to suit many of the principal tradesmen of the city. A memorial is being signed by them, urging the Council to take some definite step in the matter, or allow a private company to do so.

Taunton Electric Lighting.—The Local Government Board have granted a loan of £15,000 for the purchase of the electric light works by the Town Council, the repayment of principal and interest to extend over 25 years. The Council will meet on the 22nd inst. to consider the issue of the loan.

Electric v. Steam Underground Railways.—Some correspondence has within the last few days appeared in the *Standard* on the subject of the bad ventilation of underground railways. One correspondent makes a comparison of steam underground railways with the City and South London line, and this is the conclusion at which he arrives :—"The pure atmosphere of the South London Electric Railway tunnels and stations is due to the absence of this unpleasant gas, the equable temperature to the depth below the surface of the earth, and the comparatively small communication with the outer air during hot and close weather. It is not improbable also that the occasional small discharges of electricity at the contact of the conductor and locomotive may have something to do with the supply of ozone to the air ! ! ! "

What Next !—The latest attempt in the direction of electrical quackery is that devised by two Irishmen, believed to be father and son. The father, it appears, met a young lady and observed that her eyesight was defective. Whether she was fearful of losing her sight, or was otherwise artfully persuaded as to the necessity of procuring spectacles of some kind, is not stated, but she gave the man her address, and the same evening he called upon her, bringing with him a pair of spectacles which he declared contained electricity, and stated them to be worth £10. He succeeded in securing £4 from her for these so very valuable spectacles, which she, of course, soon found to be of no value whatever to her, and discovered, to her annoyance, that she had been imposed upon. She has taken a wise course in prosecuting the vendor of these glasses, and his son, who also seems to have had a part in the matter. The case is before the Chester Castle Petty Sessions.

Electric Tramways in Siam.—The Bangkok Tramways Company, Limited, which, since its formation in 1889, has paid a yearly dividend of over 10 per cent., has, reports the British Consul at Bangkok, tried the experiment of substituting traction by electricity for that of ponies. The line is 6 miles in length, and the lower and most unremunerative half has been equipped with electric plant by the Short Electric Railway Company, Ohio, on the overhead wire system, at a cost of £6,500. As the electric cars have only been running little more than a month, it is only possible as yet to estimate but approximately the comparative working cost of the two methods. The wages of the drivers and conductors, office expenses, and road maintenance are practically the same. The chief expense lies in the power furnished. The maintenance of the 120 ponies, which were required to work this portion of the line, cost £100 per month, while the expenses of the electric station, including engineer's salary, fuel, oil, &c., amount to about £65 per month. The depreciation, however, which was heavy on ponies and harness, will probably be greater with electric plant, particularly as regards the rails. Should the present trial give satisfactory results, which there is little reason to doubt, a distinct saving will be gained by equipping the whole line with electric power. The additional outlay will be about £1,600, and the expenses of the electric station would only be increased from £65 to about £80 per month.

Chesterfield Electric Lighting.—The inhabitants are to be circularised by the Town Council with a view to ascertaining the number of lamps that will be required in the event of the adoption of electric lighting.

Liverpool Overhead Railway.—On the occasion of the extensive fire that occurred at Liverpool last Saturday week, a length of about 50 feet of the Liverpool Overhead Railway was slightly burnt. No damage of any consequence was done.

Richmond and their late Adviser.—There has been some little friction lately between Mr. Shoolbred and the Electric Lighting Committee. That gentleman, it appears, was offered £105 in respect of his charges against the Corporation, which offer he declined to entertain, and placed the matter in his solicitor's hands. As we have before stated Mr. Shoolbred demanded £240, but the Council considered £105 sufficient.

Accidental Death.—A man named Samuel Matthews, a fireman in the employ of the Chicago Illuminating Company, was accidentally killed by electricity at the World's Fair the other day. He went to the engine room to shut off a valve which was near the dynamo, and while in the act of turning the valve he laid his other hand carelessly on the dynamo brush. A charge of 4,500 volts passed through his body. With a shriek he fell unconscious on the floor, and death was almost instantaneous.

Dundee Lighting Accounts.—At a recent meeting of the Lighting Committee of the Dundee Police Commission, accounts were submitted for the supply of gas and electric light to the town lamps. From July 1st to 31st 41,068 cubic feet of gas were consumed in the town lamps, which, at 3s. 2d. per 1,000 cubic feet, cost £64 18s. From June 1st to July 31st—two months—602 Board of Trade units of electricity were supplied to the four arc lamps on the High Street, which, at 5d. per unit, gave an expenditure of £12 10s. 10d.—the total account for the public illumination of the city being £77 8s. 10d. The estimate for the Lighting Department for the current year shows an expenditure of £7,029 16s. 6d. Of this sum £140 is set down as the cost of the electric light on the High Street, and £360 for probable new lamps.

The Danger of Overhead Wires.—The question of the danger of overhead wires has been brought somewhat prominently before the public attention within the last few days. It is only when accidents causing either bad injuries or deaths, happen, or when heavy monetary damages have to be paid, that the real importance and seriousness of the danger is evident to the general populace. What might have proved a fatal accident, but, fortunately, turns out to be a very serious one only, without causing loss of life, happened in June last. A greengrocer named John Hart, and his son, were driving home from market with their cart laden with fruit ; the father was driving, and his son sat on the load. On their arrival at the corner of Jew's Walk, York Road, Wandsworth, where some of the servants of the National Telephone Company were engaged repairing the wires at the top of a house, one of the wires suddenly fell, catching the elder plaintiff round the neck and nearly strangling him. The cart and its contents were damaged, and the son was instantly shot into the road, thereby sustaining severe injuries. Plaintiff, fortunately, was possessed of sufficient presence of mind to leave hold of the reins and catch the wire with his hands. His neck from ear to ear was abraded, and he appears to have had a narrow escape of his head being severed from his body. The injuries afterwards turned out to be far more serious than was at first thought, and even at present the plaintiff is often in a half-suffocated condition ; sometimes in the night he will wake gasping for breath. When the case came on in the County of London Sheriffs' Court, Holborn, last Friday, medical evidence was given to the effect that the man's larynx was nearly closed. For the defence, exaggeration of the injuries was pleaded, but the jury assessed the father's damages at £195, while the son, by mutual agreement with the company, was allowed £60 and costs.

Dorchester Electric Lighting.—Three months ago the Town Council resolved to pay 20 guineas to Messrs. Newton and Co., of Taunton, for a report on the best means of lighting the town by electricity. Messrs. Newton have not yet presented the report, and the Council are expressing their impatience by letter.

Electric Light at Jerusalem.—The *Jewish Chronicle* states that the French Consul at Jerusalem has had his house lit by electricity, and the Municipality of Jerusalem are desirous of electric lighting the streets of the town. They are considering a proposal made by one Gucksmann, who says, if authorised to execute the work, he could complete it by January next.

Telephone Wires.—In the House of Commons the other day, Mr. A. Morley, in reply to Captain Bagot, said the powers to place telephone wires or tubes underground, either in London or other towns, were regulated by statute, and were in all cases subject to the consent of the local authorities, with an appeal in certain cases to a police or stipendiary magistrate or county-court judge, and a further appeal to the Railway Commissioners.

The Parisian Compressed Air Company.—The Parisian Compressed Air Company is about to make considerable changes in its system of distribution. An important electrical station will be established in the Rue Saint-Roch, and will contain a certain number of batteries of Tudor accumulators. Up to the present, the work has been confined to the establishment of canalisations in the streets. The cables in use are Siemens's armoured cables, encased in lead, and laid directly in the ground in a layer of sand. Canalisations of three and five wires have thus been laid in the Boulevard Montmartre, the Boulevard Poissonnière, the Rue Poissonnière, and the Avenue de l'Opéra. We have not as yet any further information, but the work will soon be completed, and the distribution of electrical energy effected.

The Charges on the Electric Railway.—From time to time complaints have been very rife regarding the variable fares passengers are charged on the City and South London Railway. Omnibus companies are fined for raising their fares, and questions are even asked in the Parliament Houses as to the permissibility of fares being raised by directors of the companies for universal holidays just because there is certainty of voluminous traffic. "A Victim" who travelled from Kennington Oval on Bank Holiday ventilates this grievance in the *Star*. In the evening, when play at the Oval was over, he returned by the electric railway, and was confronted by a placard, "Fare any distance, 3d.," instead of the usual time-table. He is naturally led to ask in his letter, "At any times during the day, when it may suit its own sweet will, is the electric railway company within its rights in trebling its ordinary charge for conveying simply because at these times it is assured of a large number of passengers?"

Glasgow Telephones.—In our last issue we had a note on this subject, and stated how the matter stood as regards the Glasgow Corporation. The manager of the National Telephone Company in that district has now issued a circular to subscribers, in which he states that the discomfort occasioned to some of the subscribers during the recent change in the system of operating the Glasgow switch-room of the company has been a matter of great regret to the directors, and he asks for forbearance for any shortcomings that may exist for a week or two longer. It was only after grave consideration and at a very heavy expenditure of capital that the wire-call system was adopted, and the directors believe that when subscribers and operators get accustomed to the system they will find it much superior to anything that has hitherto been in existence in this locality. The instructions recently issued are elaborated, and, in conclusion, the subscribers are invited to co-operate in making the new arrangement a success. Quite a large number of letters have been appearing in the *Glasgow Herald* lately from the pens of users of the telephone system there, and the subject seems to be exciting much interest.

Tiverton Electric Lighting.—The Board of Trade have deferred revocation of the provisional order for twelve months.

Halifax Electric Lighting.—A Local Government Board inquiry was held on 16th, regarding application for borrowing £30,000 for electric lighting purposes.

Hove Vacancy.—There were 43 applicants for the vacant post of electrical engineering assistant. A temporary engagement has been made.

Whitehaven Harbour Lighting.—The Town Harbour Trust have confirmed the arrangement come to between the Harbour Committee and the Electric Lighting Committee for lighting the harbour by electricity.

Shoreditch Electric Lighting Scheme.—The vestry have resolved to take no further action in regard to the erection of an electric lighting station until the financial statement and report of the committee be received.

Dust Destructors and Electric Lighting.—A Mr. Collins, who read a paper before the Ratepayers' Association last week, recommends the purchase of a dust destructor by the Hammersmith Vestry. This he states could be used for generating electricity.

A Large Electric Crane.—Probably the most powerful electric travelling crane that has yet been worked is that now in use at the Creusôt works of Messrs. Schneider and Co. This crane is capable of lifting a dead weight of 150 tons, and is actuated by two motors of the Ganz type. Each motor is designed to take 45,000 watts. All the fittings required for the working of the motors are grouped together in the attendant's cabin. Amongst these may be noted a sulphate of copper rheostat, which enables the motors to be started without shock. To do this the main switch is closed, and the electrodes of the rheostat brought gradually into contact. A second metallic rheostat is also provided, which enables the strength of the magnetic field and the speed of the motors to be varied, beside which the work done by the two motors can be equalised by its means. A special safety device is also provided in case of the attendant allowing the chain to drop too far. This consists of a switch on the armature circuit of the motors, which is opened when the chain passes a certain point, as the field magnets still remain excited, the load is brought up almost immediately by the resistance developed to the motion of the armatures. The voltage at which the motors are designed to work is 220 volts. The dynamo providing the current has an output of 100,000 watts, and is a 4-pole Ganz machine. Both dynamos and motors are compound wound.

Brisbane Postal and Telegraph Conference.—At this Conference, which was held in March of the present year, and the proceedings at which have recently been published, it was decided that: 1. The Conference did not consider it desirable, after the recent arrangement as to rates, to give notice to the Eastern Extension Company to terminate the existing guarantee; Queensland objecting. 2. The time has arrived when a second cable route should be established *viâ* the Pacific to Vancouver, touching at such places *en route* as may be hereafter agreed upon; South Australia and Western Australia not voting. 3. That it is desirable in the interests of the public that the hour-zone system should be adopted in a modified form, so that there should be one time throughout Australia, viz., that on the 135th meridian, or nine hours east of Greenwich. With reference to the cable, the President (the Hon. J. G. Ward) stated that the length would be 7,359 miles, and the cost would be under £1,500,000. A code of "Rules and Regulations to be observed in the erection or laying of Electric Light and Power Wires," based on the Board of Trade Rules, and adapted to the special conditions and requirements of the Australian colonies, was also adopted. We should add that the "List of Electric Lighting Central Stations in Great Britain," which was compiled especially for the ELECTRICAL REVIEW, has been reproduced in full in the Report, but not acknowledged.

Worcester Electric Lighting.—Mr. W. H. Preece has been appointed consulting engineer to the City Council.

Coatbridge Municipal Buildings.—It has been decided to light the new municipal buildings by electricity.

Explosion.—A few days ago an explosion occurred in London Street, Norwich. Some gas somehow or other got into one of the electric light boxes in the pavement, with the result that a good deal of the pavement, also the electric light box, were blown into the air. Nobody was injured.

Twickenham and Electric Lighting. — Two electric lighting schemes have been submitted to the Local Board by Messrs. Hammond & Co. One of the schemes suggests 100 arc lamps for street lighting, and a supply equal to 15,000 incandescent lamps for private lighting. The matter is to receive further consideration.

Harrogate Electric Lighting.—The Electric Lighting Committee recommend the Council to carry out the electric lighting order themselves, and that Mr. Wilkinson be appointed electrical engineer to the Corporation, and that he work out the details of the scheme. Further, that sanction be applied for to borrow the necessary money. Mr. Wilkinson considers that the installation could be supplied and carried on for £12,000, and that it would pay working expenses in a year. The matter has been postponed for a few days.

Coventry and Electric Lighting.—The Electric Lighting Committee, who have prepared a report in conjunction with Mr. Holmes, presented it on Tuesday last. The Council are recommended to keep the lighting in their own hands, and to commence operations immediately. Mr. Holmes recently recommended the low tension system, but the Committee now advise adoption of the high tension system for private lighting, street lighting not being in the meantime undertaken. Mr. Holmes mentioned £32,000 as the probable expenditure, whereas the committee say £15,000 will be sufficient.

The Pacific Cable.—The *Standard* Berlin correspondent wrote on Wednesday as follows:—"The new Pacific cable from Australia to California appears to attract even more attention in Berlin than in London. The section from Sydney to New Caledonia will be 1,600 kilometres, or about 1,000 English miles, in length, and will probably be completed next week. The laying of the remaining sections to Fiji, the Samoa Islands, and Honolulu, and thence to California, will be proceeded with as soon as a complete agreement has been arrived at between the different Governments concerned. The *Frankfurter Zeitung* states that the German Imperial Post Office has already declared its readiness to grant a subsidy towards the expense of completing the part between the Fiji and Samoa Islands."

Chelsea Electric Supply Corporation v. London Electric Supply Corporation. — Before Mr. Justice Wright, on Wednesday, application was made *ex parte* on behalf of the plaintiff company for an injunction extending over a week restraining the defendants from laying any distributing mains for supplying the electric light within the area supplied by the plaintiffs, except in accordance with the terms of an agreement entered into between the two companies in July last. There had been correspondence between the parties, and the defendants having on Friday last justified what they were doing, this action was brought. Mr. Morton, Q.C., who made the application, on being called upon to explain the urgency of the matter, stated that the plaintiffs might be called upon to supply adjoining owners. Mr. Justice Wright granted an injunction over next Wednesday, but intimated that, in case the defendants felt that the order would do them any harm, they could apply to him on Thursday (yesterday) in Chambers to dissolve the injunction.

Resignation.—Alderman Priestman, who has for some time been chairman of the Gas and Electricity Committee at Bradford, has decided to relinquish that post in November.

Appointment.—Mr. W. G. P. M'Muldrew, of 4, Alexandria Drive, Sefton Park, has been appointed electrical inspector for the City of Liverpool, at a salary of £150 for the first year, £160 the second, and £170 the third.

Rye Lighting.—When the Town Council the other day had before them the question of the renewal of contracts for lighting the district by gas, the matter was referred back to the Finance and General Committee, one member making a suggestion regarding electric lighting.

Cardiff Electric Lighting.—The street lamps in some streets are to be placed at distances of 50 yards, which is less than in the City of London, while in other streets the maximum distance will not exceed that of the St. Pancras district.

Montrose and Electric Lighting.—At a recent meeting of the Police Commission, in reply to a member, it was stated that the electric lighting report had not yet been received from Mr. Bryson, but evidently it will be forthcoming shortly.

Accident on the South London Electric Railway.—On Tuesday evening last much inconvenience was caused to passengers on this railway by the bursting of the main water pipe at the Oval Station. The pipe is used for conveying water to the hydraulic lifts, and the pressure is consequently very great. Before the supply could be turned off the water had partially flooded the line, and it was with great difficulty that the trains could proceed.

Electric Lighting at Lille.—The town of Lille, in the north of France, will soon have an electrical energy station. The distribution employed is worthy of special mention. The motive power will be supplied by three gas motors of 120 H.P. Each motor will work two Rechniewski continuous current dynamos of 36 kilowatts (125 volts, 280 ampères). The distribution will be effected by feeders and three wires; the works are now in course of construction. The canalisation will be underground, and will consist of cables insulated by means of gutta-percha and armoured, and placed in a thick layer of sand. At the crossways the cables will be placed in tubes of sheet iron. The distribution to the consumers will be effected with a difference of potential of 110 volts; the loss in the feeders will be from 4 to 5 volts. The whole will be completed by a battery of accumulators, capable, if necessary, of furnishing 80 kilowatts. The choice of gas motors in preference to steam motors has, it appears, been dictated by considerations of economy.

Some E.M.F. Measurements.—The electromotive force of systems composed each of an oxidising and a reducing agent separated by an indifferent salt solution, or by mercury, has recently been the subject of careful measurement in an investigation by W. D. Bancroft. Within an experimental error of about $\pm$ 0·02 volts, the electromotive force of the cells was found to be quite independent of the nature of this connection, and also independent of the nature of the electrodes. He succeeded in demonstrating that the electromotive force is of an "additive" character, being the sum of the differences of potential between the electrode and the solution: it was found, also, to remain constant for a wide range of concentration. The only effect observed to be exercised by the nature of the indifferent (*i.e.*, the non-oxidising and non-reducing) ion upon the electromotive force was, that a free acid is a stronger oxidising agent than is the corresponding salt, the contrary holding for reducing agents. Further details, including tables of galvanometer measurements, may be consulted in the *Zeitschrift für Physikalische Chemie*, x., p. 387.

Dublin Libraries.—Capel Street Library is to be lighted by electricity, and a tender for the work has been accepted.

Breakdown of the Electric Lighting in St. Pancras.—While the conflagration at Messrs. Bowman's, High Street, Camden Town, on Monday night was at its height, it was noticeable that the electric street lights were gradually losing their brilliancy. This went on until at 11 o'clock the lights went out altogether. At the same time the fire was extinguished, and High Street was in complete darkness for more than an hour, with an excited mob of many thousand persons.

Oscillations of Small Wave-Length.—A new form of apparatus for producing Hertzian oscillations of very short wave-lengths has been devised by A. Righi. It consists of two ebonite rods fitted with metal balls at each end, and placed between the dischargers of an ordinary Holtz machine in such a way that a gap of about 4 cm. exists next to the ends of the dischargers, while one of 3 mm. is between the two rods. The rods are placed to produce this arrangement end on, and they pass through the sides of a glass vessel filled with oil, so that the gap at the middle pair of knobs is surrounded with oil. The resonator consists of a nearly complete circle of wire, the gap being filled with a Geissler tube. With metallic balls 4 cm. in diameter, the wave lengths of the radiation obtained was 20 cm., whilst with balls of 1·3 cm. diameter the wave-length was about 7 cm. Another form of resonator consisted of a rectangular strip of silvered glass, from which the varnish had been removed, and on which a line had been drawn with a diamond, dividing the strip of silver into two equal parts, and so form a spark-gap varying in breadth from one to two-thousandths of a millimetre. A parabolic metallic reflector placed behind the resonator served to make the spark visible at a distance of 6 metres from the oscillator. Hence this apparatus could be used for lecture purposes.

The Electric Tramway at Marseilles.—Marseilles has for some months now possessed an electric tramway which has, up to the present, worked satisfactorily. As it is the most important installation of the kind in France, a detailed description will be of interest. The line is 6 kilometres long, and there are 8 cars running on weekdays and 12 on Sundays, each car containing from 40 to 50 passengers. The speed varies from 10 to 20 kilometres per hour, according to whether the road is hilly or level. The electrical energy station, situated at one extremity of the line, contains three Naeyer boilers, supplying steam to three compound Hoffmann engines, vertical type, with two cylinders of 100 H.P. each. Each steam engine directly works a 66-kilowatt compound dynamo of the Manchester type. The dynamos are coupled in parallel according to the requirements of the service. Special precautions are taken with this operation, since compound dynamos are used. The line is overhead, and consists of a wire of silicious bronze, 6 millimetres in diameter; the return is constituted by the rails. The total insulation resistance in dry weather has been found to be equal to 60,000 ohms, or about 360,000 ohms per kilometre; in wet weather it fell to 35,000 ohms. The cars were constructed at Marseilles, by the General Tramways Company. They each contain two electric motors of 13 H.P., each of which works an axle by means of a worm, catching in a helicoidal wheel. The maximum angular speed of the motors is 1,450 revolutions per minute. The regulation is effected by the introduction of graduated resistances into the circuit, or by the suitable shuntage of excitation resistances. We cannot here go further into these details; but the various regulations correspond to seven different rates of speed, as explained by the company's engineer in a note published by the *Bulletin Technologique des Arts et Métiers*, July, 1893. We may mention in conclusion an electric brake arranged on the cars which simply closes on itself the circuit of the motors, when the circuit of the line has been interrupted, the car rolling by its own weight on an incline. These are the principal points of this interesting installation. The first months of working have given the following results:—The work required has been from 1 to 1·2 H.P. hours per car kilometre, and from ·09 to ·12 per ton kilometre; the consumption of coal of ordinary quality has been from 2 to 3 kg. per car kilometre, or ·1 to ·3 kg. per ton kilometre.

Obituary.—Professor Charcot, the celebrated physician and specialist at the Salpêtrière Hospital in Paris, died on 16th inst. at Morvan.

NEW COMPANIES REGISTERED.

Beach & Harris Cycle and Engineering Company, Limited (39,406).—This company was registered on the 10th inst. with a capital of £25,000 in £1 shares; to adopt an agreement made on the 9th inst. between Hy. Beach, J. T. Harris, and others, for the sale to and purchase by the company of the business of Messrs. Hy. Beach and J. T. Harris, of 14 and 14A, Fortess Road, Kentish Town, N.W., cycle manufacturers and engineers, and to continue the business in all its branches, including the trades of general and electrical engineers. The subscribers (with 100 shares each) are: F. I. Graham, 21, Connagh Road, W., Major-General (retired); A. McKeand, 54, Old Broad Street, E.C., merchant; J. P. Clayton, 71, Gower Street, captain and treasurer; J. B. Clark, Birstall Lawn, Leicester, gentleman; Hy. Beach, 14 and 14A, Fortess Road, N.W., engineer; J. T. Harris, 55 and 56, Chancery Lane, W.C., cycle manufacturer; J. W. Gleed, Spalding, gentlemen. The first directors are F. J. Graham, A. McKeand, J. P. Clayton, J. B. Clark, J. W. Gleed, and (after allotment) Arthur Ormsby and J. T. Harris. Qualification, 100 shares; remuneration, £200 per annum each, and certain percentage. The managing director is to receive an annual salary of £312 under any circumstances, and 10 per cent. of all profits made by the company, provided the shareholders have received 5 per cent., or a 5 per cent. dividend can be shown. Registered office, 55 and 56, Chancery Lane, W.C.

General Electrolytic Parent Company, Limited (39,358).—This company was registered on the 31st ult., with a capital of £24,000, in £1 shares, to carry out a specified agreement to acquire patents and rights as to any invention or process which may seem capable of being used for any of the purposes of the company; to manufacture alkalies, chlorine and other chemical compounds arising therefrom, and to undertake the business of manufacturing chemists, electro-metallurgists, &c. The subscribers (with 1 share each) are: W. H. Sanders, 61, Lorimore Road, S.E., clerk; A. H. Wilkins, West Kensington Park, W., clerk; A. W. Barr, Torry Glen, Chingford, accountant; H. Roach, Lower Clapton, clerk; J. Murray, 3, Cecley Villas, Huntingdon Road, East Finchley, N., accountant; E. Giles Winn, 21, Lorn Road, Brixton, sign writer; W. J. Robins, Copthall Hall House, E.C. The regulations of Table A apply, with few exceptions. Registered by Wm. Bohm, 23, Old Jewry, E.C., solicitor.

OFFICIAL RETURNS OF ELECTRICAL COMPANIES.

W. T. Henley's Telegraph Works Company, Limited.—The annual return of this company shows that out of a nominal capital of £100,000 in 7,000 ordinary and 3,000 preference shares of £10 each, 6,837 ordinary, and the whole of the preference shares, have been taken up. The full amount has been called on all these; £68,370 has been received on behalf of the former class and £30,000 on behalf of the latter.

Latimer Clark, Muirhead & Co, Limited.—The annual return of this company was filed on the 24th ult., and from it it appears that out of a nominal capital of £100,000 in £10 shares, 4,709 shares have been taken up. The sum of £47,090 has been received in payment of these shares.

Greenwood & Batley, Limited.—The annual return of this company was filed on the 1st ult. There have been 11,066 preference and 18,052 ordinary shares taken up out of 14,000 preference and 26,000 ordinary shares of £10 each. A sum of £10 has been called on 9,600 preference and 16,800 ordinary, and £3 has been called on 1,466 pre-

ference and 1,252 ordinary shares. The total amount of calls received equals £198,834, and £73,320 has been agreed to be considered as paid.

Lineff Electric Traction and Lighting Syndicate, Limited.—The capital of this concern has been raised from £10,000 to £15,000.

CONTRACTS OPEN AND CLOSED.

OPEN.

Aberystwyth.—September 8th. Tenders wanted for execution and maintenance of electricity supply works within the borough. Further details appear among our advertisements.

Bolton.—September 16th. Supply and fixing of alternating current transformers. For further particulars see our advertisements.

Dewsbury.—August 31st. The Guardians have under consideration the question of lighting the workhouse and premises by electricity, and are prepared to receive tenders, accompanied in each case by plan, specification, and full particulars of the method to be adopted in fitting installations for the purpose. Tenders to be left at the Union Offices, Wellington Street, Dewsbury, by 31st inst. Mr. J. Peace, clerk.

Plymouth.—"R. R.," *Western Morning News*, Plymouth (manufacturing firm), invites practical engineers to write him with a view to lighting his premises by electricity.

CLOSED.

Bolton.—The tender of the Brush Electrical Engineering Company, Limited, has been accepted for the supply of dynamos and alternators.

Burton.—The tender of Messrs. John Fowler & Co., Limited, for an overhead travelling crane for the electric light engine house, at a cost of £337, and that of Messrs. Bryan, Donkin & Co., for fitting furnaces and boilers in connection with the new works, at £285, on certain conditions, have been accepted.

Cardiff.—The tender of Mr. C. J. Davis, of Newington Causeway, for the provision of copper post lanterns at £5 5s. per lamp, has been accepted.

Ealing.—Messrs. Neil & Co.'s (of Burdett Road) tender for the central station building, has been accepted at £7,963.

Hampstead.—The tenders received for the electric lighting of Hampstead were as follows:—(*a*). For the buildings (including chimney shaft), twelve tenders:—

Messrs.	Yerbury & Sons	£10,870
"	Kilby & Gayford	10,634
"	Holliday & Greenwood	10,555
"	Simmons Brothers	10,300
"	Reid, Blight & Co.	10,300
"	Chessum & Sons	10,185
"	Neil	10,000
"	Wall Brothers	9,825
"	McCormick & Sons	9,700
"	Ballard	9,477
"	Allen & Sons	9,339
"	"	9,189

(*b*). For the plant—thirty-one tenders, of which number six only were from firms tendering for the *whole* of the sections included in the specifications, viz.:—

The Brush Company		£22,047
Messrs. Latimer Clark & Co.		21,850
" "	(alternative tender) ...	21,129
" Sharp & Kent		21,572
" Crompton & Co.		21,512
The Electric Construction Corporation		21,232
Messrs. Siemens Brothers & Co.		19,914
" "	(alternative tender)	19,120

The electric lighting committee say that regarding the buildings the prices being much in excess of the estimate, a sub-committee was appointed to examine, in conjunction with Mr. Preece and the architect, the drawings and specifications, with a view to see whether, with a due regard to efficient work, any saving in expense could be secured in constructing the buildings and shaft. The result of this examination was that certain modifications were determined upon, the plans and specifications were revised, and the parties tendering also revised their estimates in accordance therewith, the same now being as follows:—

Messrs.	Wall Brothers	£8,425
"	Reid, Blight & Co.	8,295
"	Kilby & Gayford	8,270
"	Neil	8,092
"	Holliday & Greenwood	7,836
"	McCormick & Sons	7,794
"	Simmons Brothers	7,536
"	Yerbury & Sons...	7,350
"	Chessum & Sons	7,344
"	Ballard	7,207
"	Allen & Sons	7,100

The following were accepted:—Messrs. Yerbury & Sons, £7,350, and Siemens Brothers & Co., £19,794, which is the sum stated above, £19,914, less £120 arranged deduction.

Ship Lighting.—Messrs. W. C. Martin & Co., Glasgow, have secured the contract for the electrical installation which is to be fitted on board the ss. *Stirling*, now being constructed by Messrs. W. B. Thompson & Co., Limited. The vessel is to be engaged in the Grangemouth and Rotterdam trade. Messrs. Martin & Co., have also a contract for the fitting up of electrical machinery on board two steamers which are building at Belfast.

Worcester.—Mr. Thomas Rowbotham, of Coventry Road, Birmingham, has secured the contract for constructing a generating station at Powich. The total amount is £14,797.

BUSINESS NOTICES, &c.

Embezzlement.—Joseph Francis Chase was charged at the Guildhall on Friday last with embezzling £2 10s., received by him on March 13th last on behalf of his employers, Messrs. Alabaster, Gatehouse & Co., Paternoster Row. The accused was engaged in the Directory department at a salary of £20 per month. At the early part of this month Mr. Alabaster received a letter from the prisoner in which he said he was sailing under false colours, and had kept back over £100 of the money he had received. Mr. Strong, who prosecuted, said that the firm did not wish to press the case, but felt the necessity of bringing the accused before the Court. The prisoner pleaded Guilty, and asked to be dealt with under the First Offenders Act. Mr. Alderman Ritchie: Certainly not; I cannot deal with you as I would with a boy. You must be imprisoned and kept to hard labour for three months.

J. A. Berly's Universal Electrical Directory for 1893 (12th year), 784 pp. This standard work, which will henceforth be under the direct supervision of the proprietors, H. Alabaster, Gatehouse & Co., contains a larger amount of trade information than any other similar publication, and should be in the hands of every engineer or electrician. Free within the Postal Union for 4s.

Johnson & Phillips.—This firm having had considerable experience during the last few years with oils for insulating purposes, are now able to undertake the laying of cables for the transmission of any voltage, and guarantee the satisfactory working of same on their oil insulated system and underground mains, which they work under the patents taken out by the late Mr. David Brooks and themselves. Messrs. Johnson & Phillips have constructed at their cable wharf special machinery and oil tanks for the manufacture of this class of cable, and as all the work which they have done up to the present time has given complete satisfaction, they anticipate in the near future being able to do a very large business. It can be no longer said that this system is in its experimental stage, for, during the extremely bad weather of last winter, the whole of the distribution mains at Chatham, Rochester, and Strood, were laid down on this system. The mains consist of two high-tension feeders running from the station to seven sub-stations placed at various parts of the towns. The energy having been transformed from 2,400 volts to 110, is distributed down both sides of the street by means of low tension mains also having an oil insulation. Cast-iron house service boxes are fixed opposite every other house, and connections are made both to the transformer and houses by means of flexible lead-covered oil insulated branch mains. There is also an arc light circuit running from one end of the town to the other. Each section before being finally connected up, was severally tested with 5,000 volts alternating current, and, although the circuit was frequently broken whilst the dynamo was run at this pressure, the mains did not afterwards show any weakness when tested with a sensitive reflecting galvanometer.

Bristol Central Station.—We cull this from the *Bristol Mercury*:—"There is likely to be a stiff legal fight over the assessment of the electric light station on Temple Back. The buildings, and the instruments and apparatus, throughout the city have been assessed at £3,000 gross and £2,000 net rateable value. Against this the Corporation have appealed, and as there is no love lost between the Bristol Corporation and the Incorporation of the Poor, both sides are likely to be very firm when the appeal is heard at St. Peter's, so that it is said there will be a good chance for the lawyers to cut in. The Corporation, through the Dock Committee, have just unsuccessfully appealed against the assessment of a new shed at £630, which the authorities at St. Peter's affirmed."

Yeadon and Electric Lighting.—The Local Board have had a scheme for the lighting of a portion of the township, both public and private, by electricity, submitted by Messrs. Andrews and Preece, Limited, Bradford. They recommend 1,500 8-C.P. lamps, the cost of which, exclusive of land, building, and foundations, they put down at £3,500. The Board have resolved to make application to the Board of Trade for power to supply the electric light. They intend to visit the Morecambe Electric Light Works.

Catalogues.—Mr. A. P. Lundberg has forwarded us a copy of his August, 1893, price list, containing descriptions of his latest novelties and specialities in electric light fittings. Among the various articles described, we observe the "Unique" switch which, since its introduction last year until the present time, has demanded a sale of 29,000, and over 2,500 are still on order. Quite a number of switches are described and illustrated, and the catalogue is well worth perusal.

Electric Light at Wynberg.—The *Cape Times* for July 24th records the public opening of a central electric lighting station at Wynberg. The necessary work had been executed by the Cape Town Electric Lighting Syndicate. There was, on the occasion, an assembly of a number of influential local functionaries. The thoroughfares of the Wynberg municipality are illuminated by about 100 lamps of 20 C.P. The machinery at the station, which is situated in Church Street, comprises a 40 H.P. Marshall's engine driving two Kapp Johnson and Phillips dynamos. The three-wire system of distribution has been adopted. The dynamos are supplemented by accumulators with a capacity of 300 lamps for 9 hours. The accumulators were supplied by Messrs. Johnson & Phillips. The station at present erected is equal to a supply of 1,000 lamps, and applications are said to be so numerous that extensions are anticipated. The Cape Town Electric Lighting Syndicate have also a station at Rondebosch, which commenced operations in April. A street lighting contract was secured in April, 1892, by Messrs. Edlin & Stevenson. The station has a present supply of about 600 lamps, with many other applications in hand waiting for current. Several other municipalities in this vicinity are likewise adopting electric lighting. At Claremont, we believe, the work is now quite completed, while at Mowbray the Municipal Hall is to be lighted electrically, and 30 lamps are to be erected in the streets.

Mill Lighting.—The British Paper Company, Limited, have recently had put down a complete installation of electric light in their works at Frogmore Mill. On Thursday night, August 3rd, the current was switched on for the first time. The whole of the work has been carried out by the London and Lancashire Electric and General Engineering Company, Limited, of Dalston, N.E., one of the features of the installation being an improved system of watertight mains, joint boxes, and lamp fittings, the electric wires being drawn into wrought-iron tubes with screwed joints, the whole of which has been especially designed by Mr. C. N. Russell, A.M.I.C.E., engineer to the company, with a view of resisting the effects of steam and moisture so common to paper mills. This system has, it is said, been found to answer admirably, and has received the sanction of the various Fire Insurance Companies.

Private Installations.—An electrical installation in the Y.M.C.A. Rooms, Dundee, has just been completed. Meantime only the hall and lobby have been lit. The wires are capable of supplying nine 200 candle-power lamps. In the hall there are nine pendant lamps, each of 100 candle-power, and in the lobby are two of 32 candle-power each. The work has been carried out by Messrs. R. D. Smillie and Company, electrical engineers, Glasgow, under the supervision of Mr. J. M. M. Carr. The same firm is at present fitting an installation in the shop of Mr. James M'Lean, glass and china merchant, Crichton Street, including two 1,000 candle-power arc lamps and five of 16 candle-power.

Overton House, Mostyn Street, Llandudno, has been lighted electrically. There are 36 lamps in all. An Elwell-Parker dynamo, an Otto gas engine, and a set of accumulators, comprise the plant.

An Electrician's Affairs.—Under the failure of Thomas Fletcher, electrician, 188, Broadhurst Gardens West Hampstead, and Wallington, accounts have been filed at the London Bankruptcy Court, showing total debts £616 2s. 1d. (unsecured £554 17s. 1d.); assets £45, and a deficiency of £521 2s. 1d. The debtor has also lodged a proposal to set aside out of his future income as an electrician, the sum of £120 per annum until the creditors have received a composition of 7s. 6d. in the £1. He states that he has been in the employ of a telephone company for the last 15 years, and is now in receipt of a salary of £420 per annum. He attributes his insolvency entirely to loss and liability as surety for another person.

Telephone Wires at Romford.—At a recent meeting of the Romford Board of Health a letter was read stating that the Standing Joint Committee had decided to establish telephonic communication between Chelmsford, Brentwood, Romford, and Chadwell Heath, for the purpose of facilitating the detection of burglars, and asking the board to allow the telephonic company to erect their poles and carry the wires through the board's district free of charge. It was agreed that the clerk write stating that the board objected to poles being placed in any part of the town.

Cheltenham Electric Lighting.—At a recent meeting of the Cheltenham Town Council, Mr. George Norman brought up the committee's report, which recommended the adoption of the high-pressure alternating current system of electric lighting for the town, the supply to be undertaken by the Corporation, using the ash-destructor site for the station. Mr. W. H. Preece was present and addressed the council at some length in favour of the high-pressure system. £16,000 is to be borrowed, and tenders are to be invited for the necessary work.

Electric Cable Casings.—Messrs. Vigers Bros., of Chelsea, have sent us one of their new cards giving particulars of their electrical casings. The present list shows a great reduction in price and includes a cheaper size of No. 2 casing, also a new stock size, No. 8, with inch grooves. They have now, in addition, improved their patterns by ceasing to bead the edge and making flat centre for screws on small sizes. Mr. Boulton, we understand, has ceased to represent Messrs. Vigers Bros.

Waste Oil Filters.—We have received a copy of Messrs. A. C. Wells & Co.'s list of patent waste oil filters. A few testimonials are given from users of the filters, one being a firm of electrical engineers who express their satisfaction with the filters, which they consider well finished and perform their work satisfactorily. Nearly all the gas engine and dynamo plants the firm have put down, have these filters fitted, and use the same oil time after time.

Furnace Stoker.—Mr. Leoline A. Edwards has received an order from the Brush Electrical Engineering Company for the application of his patent stoker to a Babcock & Wilcox boiler at the bankside station of the City of London Electric Lighting Company. This, it is believed, will be a novelty in this country, for, although many of the stokers have been fitted to water tube boilers on the Continent, none, it is said, are in use here, although a large trade has been done in fitting them to Lancashire boilers.

Hotel Electric Lighting.—A new Royal Hotel has been erected at Bury, and a trial run of the electric light installation was made recently. There are in all 100 incandescent lamps of various powers. The dynamo was supplied by Messrs. Chas. Walmsley & Co., of Elton. All the bedrooms, dining room, billiard room, entrances, hall, &c., have been fitted up. The installation was carried out under the supervision of Mr. J. H. Hindle, of Bury.

Electric Light at Dundee.—A decided improvement has been made in the lighting of the Nethergate by the erection of a powerful electric lamp on the Dental Institute, belonging to Mrs. Stewart. The light is of 1,000 C.P., and has been erected by Messrs. P. B. Steel & Co., of Dundee. Mrs. Stewart contemplates introducing electricity into the interior of the establishment. The lamps will be 16-candle power.

Personal.—Mr. Robert W. Blackwell has lately dissolved his connection with Messrs. Greenwood & Batley, Limited, and is about to start business on his own account. He intends making a speciality of traction matters, and will represent certain American firms who make a speciality of such appliances as are not at present to be procured on this side of the water.

Lincoln and Electric Lighting.—Messrs. Andrew and Trotter, have given notice on behalf of the "County of London and Brush Provincial Electric Lighting Company," of their intention to apply to the Board of Trade for a provisional order to authorise the supply of electricity within this city. The matter is to be considered in committee.

Direct Spanish Telegraph Company.—During the interruption of this company's Falmouth-Bilbao cable, arrangements have been made by which telegrams for Bilbao, Madrid, and other places in Spain, can be promptly forwarded by the Eastern Telegraph Company's route.

Wakefield Electric Lighting.—The Electric Lighting Committee have visited the Leeds electric lighting station, also the works of Messrs. John Fowler & Co., Limited, and an appointment is to be made with Mr. Hammond to meet the committee on the 26th inst.

Ship Lighting.—A new twin screw steamer *Magic*, for the Belfast Steamship Company, was recently floated by Messrs. Harland & Wolff. She is lighted throughout by electricity, the total number of lights (including the signal lights), being 262.

Business Announcement.—Mr. L. H. Bloomfield of 11, Queen Victoria Street, E.C., announces that he has taken over the sole representation in the United Kingdom of Messrs. O. L. Kummer and Company, electrical engineers, of Dresden.

Weybridge Electric Light Wires.—The lighting inspectors have received a satisfactory reply from the Weybridge Electric Supply Company, Limited, with respect to the electric wires being placed underground as requested.

Rochdale.—Messrs. Laing, Wharton & Down have fitted up the sanitary works of the Corporation with electric light. On 4th inst. the light was switched on for the first time. There are about 80 lights in all of various C.P's.

Hospital Electric Lighting.—The Bristol Board of Guardians last week considered once more the electric lighting of St. Peter's Hospital, and resolved to invite tenders for a number of lamps required for the purpose.

Killarney and Electric Lighting.—Some of the Commissioners took a walk round the town the other day to inspect the public lighting, and they have now resolved to invite tenders for electric lighting.

Salt Lake and Ogden Gas and Electric Light Co.—The letters of allotment for the six per cent. first mortgage gold bonds, regarding which we had a notice last week, have been posted.

Chesterfield Telephone Wires.—The Town Council have instructed the National Telephone Company to remove all overhead wires in the town and place them underground.

Clerk of Works Wanted.—The Hampstead Vestry intend inviting applications for the post of clerk of works during the erection of the electric light station.

School Electric Lighting.—The Brentford Board of Guardians are considering the introduction of electric lighting into the schools and workhouse.

Fareham Electric Lighting.—The contract with the Fareham Electric Lighting Company has been sealed.

Aberdeen Electric Lighting.—The price to be charged consumers is expected to be 7d. per unit.

Bradford Electric Lighting.—A quarterly meeting of the Bradford Town Council was held on Tuesday. The Gas and Electricity Supply Committee submitted a resolution recommending that the necessary works required in the application of the three-wire system of electric lighting be proceeded with, at an estimated cost of £2,020. They also recommended the acceptance of the offer of the Westinghouse Electric Company, Limited, for the use of Dr. Hopkinson's patent in connection with the three-wire system, at the rate of £2 10s. per annum per ton of copper actually laid down. They proposed, further, to accept the tender of Messrs. Siemens Bros. & Co., Limited, for supplying and fixing two of Willans's engines with Siemens's dynamos and two switchboards, required for the extension of the electricity works, for the sum of £3,025; and also that two boilers be advertised for.

London Metallurgical Company, Limited.—Meetings of the creditors and shareholders of the London Metallurgical Company, Limited, were held on Tuesday, before Mr. A. S. Cully (Official Receiver). In November, 1892, the company promoted the Arcas Plating Company, with a capital of £80,000, to acquire the patent for £50,000, and the business was carried on until the property was taken possession of by a debenture holder. The accounts show total liabilities £17,896 (unsecured £11,820), assets £10,960, and a deficiency of £12,896 to the contributories. No resolution was carried at the meeting of creditors owing to an equal division of opinion; but the shareholders elected the Official Receiver to act as liquidator on their behalf.

CITY NOTES.

The Oriental Telephone and Electric Company, Limited.

THE directors' report for the year ended December 31st, 1892, to be presented at the meeting at Cannon Street Hotel, on Wednesday, the 23rd inst., at 1 o'clock p.m., reads as follows:—

"As mentioned to the shareholders at the last annual general meeting, an appeal was lodged by Mr. Ness against the decision of Mr. Justice Kekewich in the matter of the declaration and distribution of the previous dividend. The Court of Appeal having reversed the judgment of Mr. Justice Kekewich, the directors had no alternative but to submit the case to the House of Lords for a final interpretation of the agreement with the vendors. The annual meeting has consequently been delayed pending the result of this appeal. Judgment was given by the House of Lords on the 27th ult., which allowed the appeal and upheld the decision of Mr. Justice Kekewich. The dividends therefore falling to the vendor shareholders have to be paid over to the ordinary shareholders until such time as the arrears of interest due to the latter for the first five years after the incorporation of the company have been satisfied. These arrears, after payment of the last dividend, amounted to about £13,000. The revenue account for the year shows a balance to credit of £9,085 5s. 11d., which has been transferred to profit and loss, and including £1,957 16s. 4d. brought forward from 1891, there remains a balance for disposal of £11,043 2s. 3d. The directors propose to deal with this as follows: To write off £251 13s. 6d. for legal expenses; £77 10s. 4d., being 50 per cent. of the company's claim on the liquidators of the New Oriental Bank Corporation in respect of a balance at Mauritius; £533 15s. 4d. in reduction of capital expenditure; to transfer £2,500 to reserve; and to pay a dividend at the rate of 2½ per cent. on the total paid-up capital of the company, free of income tax, carrying forward £3,191 10s. 10d. This dividend, together with that declared on the vendors' shares and applied to the ordinary shares, amounts to £3 12s. 2d. per cent. on all ordinary shares issued prior to February 4th, 1886. Although the balance of revenue account shows but a small improvement over the previous year, there has been a considerable extension of business at every agency, including those of the subsidiary companies. The remittances and dividends, however, received from the East are, with the exception of Egypt, the equivalent of a silver currency, and, but for the further decline in the value of that metal during the year, the revenue account would have shown a more favourable result. The Bengal Company has paid a dividend of 6 per cent., and the Bombay Company one of 4 per cent. for the past year, the last-named company again applying Rs. 10,000 to reserve and depreciation instead of increasing its dividend. Notwithstanding that the directors of the Telephone Company of Egypt report that one of the late officials of the company had been guilty of grave irregularities, they have been able, after payment of debenture interest, to distribute the usual dividend of 6 per cent. on the preferred shares, to write off £426 7s. 4d. for depreciation, and to carry forward £1,446 7s. The China and Japan Telephone Company closed its accounts for the past year with a surplus on revenue account of £549 15s. 7d. after payment of debenture interest; the directors of that company, however, in view of currency contingencies, did not recommend a dividend, but applied the amount in part towards the reduction of capital expenditure and depreciation of stores, carrying forward the balance. The Court has finally approved the amendment of the company's memorandum of association as sanctioned by the shareholders, and the name of the company is now registered as The Oriental Telephone and Electric Company, Limited. The directors to retire at the present meeting are Messrs. G. B. Frost and B. St. John Ackers, both of whom, being eligible, offer themselves for re-election. The auditors of the company, Messrs. Deloitte, Dever, Griffiths & Co., also retire, and offer themselves for re-election."

The International Electric Subway Company, Limited.

THE following report has been sent to us by the company:—

On Thursday, August 10th, the first ordinary general meeting was held at 72, Bishopsgate Street Within, Mr. John L. Martin presiding.

The SECRETARY having read the notice convening the meeting,

The CHAIRMAN said: Since the statutory meeting held last year, two contracts for supplying the Johnstone system of conduits have been carried out, one of them being for the City of London Electric Lighting Company, Limited, who laid about ¼ of a mile of the conduit in Blackfriars. The types used was the 9-way and the 6-way, each duct or way measuring 2½ inches square. It will readily be understood that as this was the first time of laying the conduit in England, it was a most important moment for this company; it is therefore a matter for congratulation that the work done was perfectly satisfactory, the top and bottom troughs exactly fitting together, and when the conduit was keyed up it made a solid structure. It may be mentioned that no skilled labour is required and no special tools for laying the conduit; in fact, a great deal of the work can be done by boys, and, in this way, the cost of laying is much less than where separate pipes are used; each pipe would cost 6d. per yard run to lay and joint, whereas 9d. per yard run covers the cost of laying and jointing the 9-way conduit. Some of the conduit has also been supplied to the Keswick Electric Lighting Company, Limited, and their engineer was so pleased with the system, that during the last few days he had ordered some more, with handholes for making house connections. During the last month we have obtained the contract for all the electrical mains at Portsmouth; the tyres used will be a three-way and a two-way; each duct will measure 2½ inches square, and the service connections will be made by means of the handholes, which are a special feature of this system. The amount of the contract is £12,000, exclusive of accessories, and the work will be commenced in about a fortnight's time. It is most important that the system is to be laid in a well-known town like Portsmouth, for there its many advantages will be seen and understood in a way which is impossible where only a short piece of work is done. The company still owns the patents for France, Austria, Belgium and Italy, as it has not been thought advisable to dispose of these until a large contract had been obtained in England. Negotiations are now being entered into for working some of the foreign patents on a royalty. He concluded by moving the adoption of the report and accounts.

The motion was seconded and carried unanimously.

A cordial vote of thanks was passed to the directors and to the managing director, Mr. Margesson, after which the proceedings terminated.

Cuba Submarine Telegraph Company.

THE forty-fourth ordinary general meeting of the shareholders in this company was held on Wednesday, at the offices, 58, Old Broad Street, under the presidency of Mr. Thomas Greenwood.

In moving the adoption of the report and accounts, the CHAIRMAN stated that there had been an improvement in the traffic receipts of over £600 as compared with those of the June half of 1892, while the working expenses had been less by £562. There was, therefore, an improvement in their position of £1,164, which went to swell the balance carried forward to next half-year. The reserve made this half-year was precisely similar in amount to that made a year ago, but this time it had been divided, £1,500 being transferred to a reserve against any loss that might arise from the failures of banks in which the company had deposits, and £5,500 being carried to the general reserve fund; whereas a year ago the whole £7,000 was carried to the credit of the reserve fund only. He did not think they would make any great loss by the bank failures, but the half-year was sufficiently good to allow of the provision which he had mentioned. The charge for the annual payment on account of the purchase of the cable laid in 1881 between Cienfuegos and Batabano no longer appeared in the accounts, for the payment had been completed, and the property now belonged to the company.

The motion was seconded by Mr. CHARLES W. PARISH, and was carried unanimously; and dividends were afterwards declared at the rate of 10 per cent. per annum on the preference shares and 8 per cent. on the ordinary shares.

Brush Electrical Engineering Company, Limited.—There has been a gross profit on the year of £50,158, including the balance brought forward. To this has to be added £3,150 balance of premium derived from additional shares issued. After deducting all expenses there remains £26,394 odd to be dealt with. It is proposed that 6 per cent. be paid on the preference, and the directors recommend a half-yearly dividend at the rate of 7 per cent. per annum on the ordinary shares, £815 being carried forward. We shall publish the report next week.

TRAFFIC RECEIPTS.

The City and South London Railway Company. The receipts for the week ending August 13th, 1893, amounted to £826; week ending August 14th, 1892, £721; increase £105; total receipts for half-year, 1893, £5,051; corresponding period, 1892, £4,661; increase £390.

The Western and Brazilian Telegraph Company, Limited. The receipts for the week ending August 11th, after deducting 17 per cent. of the gross receipts payable to the London Platino-Brazilian Telegraph Company, Limited, were £2,354.

SHARE LIST OF ELECTRICAL COMPANIES.

Present Issue.	Name.	Stock or Share.‡	Closing Quotation, August 9th.	Closing Quotation August 16th.	Business done during week ended August 16th, 1893. Highest.	Lowest.
195,100*l*	African Direct Telegraph, Ltd., 4 p. c., Deb. Regd. and to Bearer	100	99 —102	99 —102	...	...
1,134,640*l*	Anglo-American Telegraph, Limited	Stock	49 — 50 xd	49 — 50	...	...
2,932,680*l*	Do. do. 6 p. c. Preferred	Stock	92 — 93 xd	91½ — 92½	93	92
2,876,140*l*	Do. do. Deferred	Stock	9½ — 10	9 — 9½	9 5/16	9
130,000	Brazilian Submarine Telegraph, Limited	10	11⅜ — 12⅜	11⅜ — 12¼	...	...
36,400*l*	Do. do. 5 p. c. Bonds	100	99 —103 xd	99 —103	...	...
75,000*l*	Do. do. 5 p. c., 2nd Series, repayable in June, 1906 ...	100	107 —111	107 —111	...	...
77,978	Brush Electrical Engineering Ordinary, Nos. 1 to 63,416	3	3½ — 3¼	3½ — 3⅜	3 5/16	3 1/16
75,000	Do. do. Non cum. 6 p. c. Preference, Nos. 1 to 63,416	2	2⅛ — 2⅜	2⅛ — 2⅜	2 1/16	...
125,000*l*	Do. do. 4½ per cent. Debenture Stock	Stock	107 —109	107 —109	108½	107½
20,510	Charing Cross & Strand Electricity Supply Nos. 1 to 6, 215 to 718, and 10,001 to 30,000	5	5 — 5½xd	5 — 5½	...	...
44,000	Chili Telephone, Limited, Nos. 1 to 40,000	5	2 — 3	2 — 3	...	...
630,000*l*	City and South London Railway	Stock	35 — 37	35 — 37 xd	...	...
40,000	City of London Elec. Lighting Co., Ltd., Ord. 40,001-80,000 ...	10	10⅜ — 11¼	10⅜ — 11¼	...	...
20,000	Do. do. 6 p. c. Cum. Pref., Nos. 1 to 20,000	10	12¼ — 13	12¼ — 12⅝	12⅝	12½
$ 716,000	Commercial Cable, Capital Stock	$100	120 —130	120 —130	...	...
224,850	Consolidated Telephone Construction and Maintenance, Limited ..	14/-	¼ — ¼	1/16 — 1/16	...	...
20,000	Crompton & Co., Ltd, 7 p. c. Cum. Pref. Shares, Nos. 1 to 20,000	5	4⅜ — 5¼	4⅜ — 5¼xd	...	...
50,000*l*	Do. do. 5 p. c. 1st Mort. Debs., 1—400 of £100, and "A" 1—200 of £50 each	...	101 —104	101 —104	...	...
16,000	Cuba Telegraph, Limited	10	11½ — 12½	11½ — 12½	12¼	...
6,000	Do. do. 10 p. c. Preference	10	18½ — 19½	18½ — 19½	...	...
12,931	Direct Spanish Telegraph, Limited, ... (£4 only paid)	5	2½ — 3½	2½ — 3½	...	...
6,000	Do. do. 10 p. c. Preference	5	9 — 10	8½ — 9½	8⅝	...
60,710	Direct United States Cable, Limited, 1877	20	11⅜ — 12	11½ — 11⅝	11⅝	11 1/16
400,000	Eastern Telegraph, Limited, Nos. 1 to 400,000	10	14⅜ — 15 xd	14⅜ — 15	15	14⅜
70,000	Do. 6 p. c. Preference	10	16¼ — 16⅜xd	16¼ — 16⅜	16 1/16	16 5/16
105,900*l*	Do. 5 p. c. Debs. (1879 issue), repay. August, 1899	100	106 —109 xd	106 —109	...	...
1,294,100*l*	Do. 4 p. c. Mortgage Debenture Stock	Stock	112 —115	112 —115	114½	112½
250,000	Eastern Extension, Australasia and China Telegraph, Limited ...	10	15⅛ — 15⅜	15 — 15⅛	15 1/16	15 1/16
70,600*l*	Do. 5 p. c. (Aus. Gov. Sub.), Deb., 1900, red. ann. drgs. reg. 1 to 1,049, 3,976 to 4,326	100	102 —105	102 —105	102⅜	...
250,200*l*	Do. do. Bearer Nos. 1050—3,975 and 4,327—6,400 ...	100	102 —105	102 —105	103	...
320,000*l*	Do. 4 p. c. Debenture Stock	Stock	111 —114 xd	110 —113	...	...
108,700*l*	Eastern and South African Telegraph, Ltd., 5 p. c. Mort. Deb. 1900 redeem. ann. drawings, Registered Nos. 1 to 2,343	100	101 —104	101 —104	...	...
146,800*l*	Do. do. do. to bearer, Nos. 2,344 to 5,500	...	101 —104	101 —104	...	...
300,000*l*	Do. do. 4 p. c. Mort. Debs. Nos. 1 to 2016, red. 1909	100	101 —104 xd	101 —104	...	...
49,900	Electric Construction, Limited, Nos. 101 to 45,100	10	1½ — 2	1½ — 2	...	...
19,900	*Electricity Supply Co. of Spain, Nos. 101 to 20,000	5	... ...	... ...	...	...
100,000	Elmore's French Patent Copper Depositing Co., Ltd, Nos. 1 to 66,750	2	⅛ — ¼	⅛ — ¼	...	...
91,195	Elmore's Patent Copper Depositing, Limited., Nos. 1 to 70,000 ...	2	¼ — ⅜	¼ — ⅜	...	...
67,385	Elmore's Wire Mfg., Ltd., Nos. 1 to 67,385, issued at 1 p.m., all pd.	2	⅜ — ⅝	⅜ — ⅝	...	...
20,000	Fowler-Waring Cables, Nos. 301 to 20,300 ... (£4 10s. only paid)	5	1 — 2	1 — 2	...	...
180,227	Globe Telegraph and Trust, Limited	10	9⅝ — 9¾xd	9⅝ — 9¾	9¾	9⅝
180,042	Do. do. 6 p. c. Preference	10	15⅛ — 15⅜xd	14¾ — 15⅛	15⅜	15
150,000	Great Northern Tel. Company of Copenhagen	10	19½ — 20	19½ — 20	...	...
200,000*l*	Do. do. 5 p. c. Debs. (issue of 1883) ...	100	105 —108	105 —108	...	...
12,134*l*	Greenwood and Batley, Ltd., Ordinary, Nos. 4667 to 14,000 ...	10	4½ — 5½	4½ — 5½	...	...
9,600*l*	Do. 7 p. c. Cumulative Preference, Nos. 2,667 to 8,000	10	6 — 7	6 — 7	...	...
50,000	India-Rubber, Gutta Percha and Telegraph Works, Limited ..	10	21½ — 22½	21½ — 22½	22	21½
200,000*l*	Do. do. 4½ p. c., Deb., 1896	100	102 —104	102 —104	...	...
17,000	Indo-European Telegraph, Limited	25	39 — 42	39 — 42	40½	39½
11,334	International Okonite, Ltd., Ordinary Nos. 22,667 to 34,000	10	1½ — 2½	1½ — 2½	...	...
30,000	†Liverpool Electric Supply, £3 10s. paid	5	4 5/16 — 4 7/16	4 5/16 — 4 7/16	4 7/16	4 7/16
10,000	Do. do. fully paid	5	6¼ — 6½	6¼ — 6½	6½	5⅝
37,548	London Platino-Brazilian Telegraph, Limited	10	4 — 6	4 — 6	...	...
100,000*l*	Do. do. do. 6 p. c. Debentures	100	107 —110	107 —110	...	...
49,900	*Metropolitan Electric Supply, Ltd., Nos. 6,101 to 50,000 (£9 paid)	10	5⅜ — 6¼	5⅜ — 6¼	...	...
50,000*l*	Do. 5 p.c. debentures, 1 to 5,000 in bonds of £10, £20, £40	...	102 —105	102 —105	...	...
15,000	Monte Video Telephone Co., Ord., Nos. 1 to 15,000 fully paid ...	5	1½ — 2½	1½ — 2½	...	...
28,000	Do. do. 6 p. c. Pref., Nos. 1 to 28,000 fully paid	5	3 — 4	3 — 4	...	...
458,867	National Telephone, Limited, Nos. 1. to 438,984	5	4½ — 4⅜xd	4⅜ — 4⅜	4⅜	4 7/16
15,000	Do. 6 p. c. Cum., 1st Preference	10	14½ — 15¼xd	14½ — 15¼	15 5/16	15¼
15,000	Do. 6. p. c. Cum. 2nd Preference	10	14 — 14½xd	14 — 14½	14⅜	14½
90,950	Do. 5 p. c. Non-cum. 3rd Pref., Nos. 1 to 90,950 ...	5	5¼ — 5¼xd	5¼ — 5⅜	5⅜	
726,477*l*	Do. 4½ p.c. Deb. Stock Prov. Certs. fully paid ...	...	110 —113	111 —113	111⅞	111
48,800*l*	New Telephone, Limited, Nos. 25,901 to 74,700 ... (£2 paid)	10	... ...	... ...	...	...
6,451	Notting Hill Electric Lighting Company, Limited, fully paid ...	10	5 — 6	5 — 6	...	...
220,000	Oriental Telephone, Ltd., Nos. 80,001 to 300,000 (11s. only paid)	1	¼ — ¼	1/16 — 1/16	...	...
100,000*l*	Pacific and European Tel., Ltd., 4 p. c. Guar. Debs., Nos. 1 to 1,000	100	100 —103	100 —103	...	...
11,802	Reuter's Limited	8	4½ — 5½	4½ — 5½	...	...
18,680	St. James's & Pall Mall Electric Light Co., Ltd., Ord., 101—18,780	5	6¼ — 6⅝	6¼ — 6⅝	6⅜	...
20,000	Do. do. 7 per cent. pref., Nos. 20,081 to 40,080	5	7⅜ — 8¼xd	7⅜ — 8¼	8 1/16	...
3,381	Submarine Cables Trust	Cert.	115 —120	115 —120	116	...
78,949	Swan United Electric Light, Limited ... ... (£3¼ only paid)	5	2 — 2½	2 — 2½	...	...
37,350	Telegraph Construction and Maintenance, Limited	12	33 — 35 xd	33 — 35	34½	33½
150,000*l*	Do do. do. 5 p. c. Bonds, red. 1894	100	101 —104	101 —104	101⅝	...
58,000	United River Plate Telephone, Limited	5	2 — 2½	2 — 2½	...	...
146,370*l*	Do. do. 5 p. c. Debenture Stock ...	Stock	90 — 100	90 —100	...	...
15,609	West African Telegraph, Limited, Nos. 7,501 to 23,109	10	5½ — 6½	5½ — 6½	...	...
260,900*l*	Do. do. do. 5 p. c. Debentures	100	99 —102	99 —102	...	...
30,000	West Coast of America Telegraph, Limited	10	2½ — 3½	2½ — 3½	...	...
150,000*l*	Do. do. do. 8 p. c. Debs., repayable 1902 ...	100	97 —101	97 —101	...	...
64,242	Western and Brazilian Telegraph, Limited	15	6⅞ — 7¼	6½ — 6⅝	6⅝	6 7/16
33,129	Do. do. do. 5 p. c. Cum. Preferred	7½	5⅞ — 6½	5⅝ — 6½	6	...
33,129	Do. do. do. 5 p. c. Deferred	7½	1½ — 1⅝	1½ — 1⅝	1½	...
178,200*l*	Do. do. do. 6 p. c. Debentures "A," 1910 ...	100	103 —106 xd	103 —106	104	...
222,700*l*	Do. 6 p. c. Mort. Debs., series "B" of '80, red. Feb., 1910	100	103 —106 xd	103 —106	...	...
88,321	West India and Panama Telegraph, Limited	10	1 — 1½	1 — 1½	1 1/16	...
34,563	Do. do. do. 6 p. c. 1st Preference ...	10	10¼ — 10⅜	10¼ — 10⅜	10½	...
4,669	Do. do do. 6 p. c. 2nd Preference ...	10	9 — 10	9 — 10	...	...
80,000*l*	Do. do. 5 per cent debentures (1917) No. 1 to 1,000	100	105 —108	105 —108	...	...
$1,214,000	Western Union of U.S. Tel., 7 p. c. 1st Mortgage (Building) Bonds	$1,000	120 —125	120 —125	...	...
169,000*l*	Do. do. 6 p. c. Sterling Bonds	100	101 —104	101 —104	...	...
59,900	*Westminster Electric Supply Corp., Ord., Nos. 101 to 42,953 ...	5	5 — 5¼xd	5 — 5½	5⅜	5⅛

* Subject to Founders' Shares. † Quotations on Liverpool Stock Exchange. ‡ Unless otherwise stated all shares are fully paid.

LATEST PROCURABLE QUOTATIONS OF SECURITIES NOT OFFICIALLY QUOTED:—Birmingham Electric Supply Company, Ordinary of £5 (fully paid), 5⅜—6.—Brush Company 4½ per cent. Debenture stock, issued at 1 per cent. premium, 100—103.—Electric and General Investment, shares of £5 (£1 paid), 1⅞—2¼.—Founders' shares, 200—225.—House to House Company (£5 paid) 1¼—2¼.—Do. 7 per cent. Preference of £5, 5—5⅛.—Do. 6 per cent. Debentures of £100, 97—102.—Kensington and Knightsbridge Electric Lighting Company, Limited, Ordinary Shares £5 (fully paid), 5⅞—6⅛, 1st Preference Cumulative 6 per cent., £5 (fully paid) 6—6⅛.—Manchester, Edison and Swan Company, 49 (£1 paid). ¼—⅜.—Queen Anne's Mansions Lighting and Heating 6 per cent. £10 Debentures, 101—103.

Bank rate of discount, 4 per cent. (August 10th, 1893).

ON LIGHT AND OTHER HIGH FREQUENCY PHENOMENA.*

BY NIKOLA TESLA.

(*Concluded from page* 154.)

Coming now to the most interesting of these phenomena, the incandescence or phosphorescence of gases, at low pressures or at the ordinary pressure of the atmosphere, we must seek the explanation of these phenomena in the same primary causes, that is, in shocks or impacts of the atoms. Just as molecules or atoms beating upon a solid body excite phosphorescence in the same or render it incandescent, so when colliding among themselves they produce similar phenomena. But this is a very insufficient explanation and concerns only the crude mechanism. Light is produced by vibrations which go on at a rate almost inconceivable. If we compute, from the energy contained in the form of known radiations in a definite space the force which is necessary to set up such rapid vibrations, we find, that though the density of the ether be incomparably smaller than that of any body we know, even hydrogen, the force is something surpassing comprehension. What is this force, which in mechanical measure, may amount to thousands of tons per square inch? It is electrostatic force in the light of modern views. It is impossible to conceive how a body of measurable dimensions could be charged to so high a potential that the force would be sufficient to produce these vibrations. Long before any such charge could be imparted to the body it would be shattered into atoms. The sun emits light and heat, and so does an ordinary flame or incandescent filament, but in neither of these can the force be accounted for if it be assumed that it is associated with the body as a whole. Only in one way may we account for it, namely, by identifying it with the atom. An atom is so small, that if it be charged by coming in contact with an electrified body and the charge be assumed to follow the same law as in the case of bodies of measurable dimensions, it must retain a quantity of electricity which is fully capable of accounting for these forces and tremendous rates of vibration. But the atom behaves singularly in this respect, it always takes the same "charge."

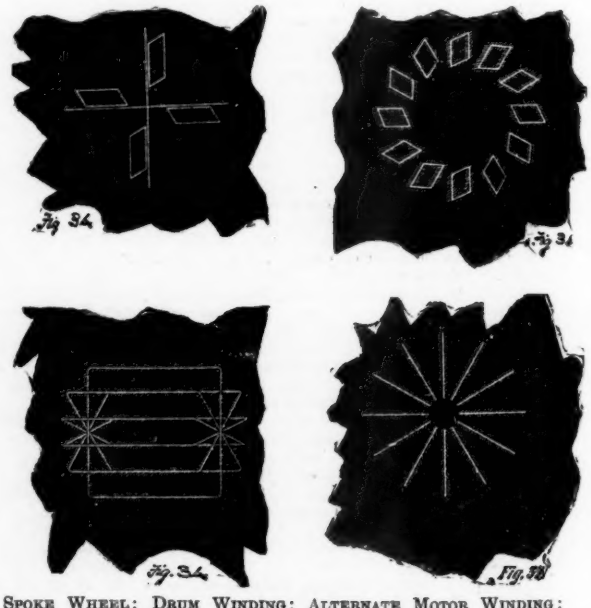
It is very likely that resonant vibration plays a most important part in all manifestations of energy in nature. Throughout space all matter is vibrating, and all rates of vibration are represented, from the lowest musical note to the highest pitch of the chemical rays, hence an atom, or complex of atoms, no matter what its period, must find a vibration with which it is in resonance. When we consider the enormous rapidity of the light vibrations, we realise the impossibility of producing such vibrations directly with any apparatus of measurable dimensions, and we are driven to the only possible means of attaining the object of setting up waves of light by electrical means and economically, that is, to affect the molecules or atoms of a gas, to cause them to collide and vibrate. We then must ask ourselves, How can free molecules or atoms be affected?

It is a fact that they can be affected by electrostatic force, as is apparent in many of these experiments. By varying the electrostatic force we can agitate the atoms, and cause them to collide under evolution of heat and light. It is not demonstrated beyond doubt that we can affect them otherwise. If a luminous discharge is produced in a closed exhausted tube, do the atoms arrange themselves in obedience to any other but to electrostatic force acting in straight lines from atom to atom? Only recently I investigated the mutual action between two circuits with extreme rates of vibration. When a battery of a few jars (c, c, c, c, fig. 32) is discharged through a primary, P, of low resistance (the connections being as illustrated in figs. 19a, 19b, and 19c), and the frequency of vibration be many million, there are great differences of potential between points on the primary not more than a few inches apart. These differences may be 10,000 volts per inch, if not more, taking the maximum value of the E.M.F. The secondary, s, is therefore acted upon by electrostatic induction, which is in such extreme cases of much greater importance than the electro-dynamic. To such sudden impulses the primary as well as the secondary are poor conductors, and therefore great differences of potential may be produced by electrostatic induction between adjacent points on the secondary. Then sparks may jump between the wires and streamers become visible in the dark if the light of the discharge through the spark gap, d, d, be carefully excluded. If now we substitute a closed vacuum tube for the metallic secondary, s, the differences of potential produced in the tube by electrostatic induction from the primary are fully sufficient to excite portions of it; but as the points of certain differences of potential on the primary are not fixed, but are generally constantly changing in position, a luminous band is produced in the tube, apparently not touching the glass, as it should, if the points of maximum and minimum differences of potential were fixed on the primary. I do not exclude the possibility of such a tube being excited only by electro-dynamic induction, for very able physicists hold this view; but, in my opinion, there is as yet no positive proof given that atoms of a gas in a closed tube may arrange themselves in chains under the action of an electromotive impulse produced by electro-dynamic induction in the tube. I have been unable, so far, to produce striæ in a tube, however long, and at whatever degree of exhaustion, that is, striæ at right angles to the supposed direction of the discharge or the axis of the tube, but I have distinctly observed in a large bulb, in which a wide luminous band was produced by passing a discharge of a battery through a wire surrounding the bulb, a circle of feeble luminosity between two luminous bands, one of which was more intense than the other. Furthermore, with my present experience, I do not think that such a gas discharge in a closed tube can vibrate, that is, vibrate as a whole. I am convinced that no discharge through a gas can vibrate. The atoms of a gas behave very curiously in respect to sudden electric impulses. The gas does not seem to possess any appreciable inertia to such impulses, for it is a fact that the higher the frequency of the impulses, with the greater freedom does the discharge pass through the gas. If the gas possesses no inertia, then it cannot vibrate, for some inertia is necessary for the free vibration. I conclude from this that if a lightning discharge occurs between two clouds, there can be no oscillation, such as would be expected, considering the capacity of the clouds. But if the lightning discharge strike the earth, there is always vibration—in the earth, but not in the cloud. In a gas discharge each atom vibrates at its own rate, but there is no vibration of the conducting gaseous mass as a whole. This is an important consideration in the great problem of producing light economically, for it teaches us that to reach this result we must use impulses of very high frequency and necessarily also of high potential. It is a fact that oxygen produces a more intense light in a tube. Is it because oxygen atoms possess some inertia and the vibration does not die out instantly? But then nitrogen should be as good, and chlorine and vapours of many other bodies much better than oxygen, unless the magnetic properties of the latter enter prominently into play. Or, is the process in the tube of an electrolytic nature? Many observations certainly speak for it, the most important being, that matter is always carried away from the electrodes and the vacuum in a bulb cannot be permanently maintained. If such process takes place in reality, then again must we take refuge to high frequencies, for with such, electrolytic action should be reduced to a minimum, if not rendered entirely impossible. It is an undeniable fact that with very high frequencies, provided the impulses be of a harmonic nature, like those obtained from an alternator, there is less deterioration and the vacua are more permanent. With disruptive discharge coils there are sudden rises of potential and the vacua are more quickly impaired, for the electrodes are deteriorated in a very short time. It was observed in some large tubes, which were provided with heavy carbon blocks, B, B_1, connected to platinum wires, w, w_1, (as illustrated in fig. 33),

Fig. 33

CARBON DEPOSIT IN TUBE IN A MAGNETIC FIELD.

and which were employed in experiments with the disruptive discharge instead of the ordinary air gap, that the carbon particles under the action of the powerful magnetic field in which the tube was placed, were deposited in regular fine lines in the middle of the tube as illustrated. These lines were attributed to the deflection or distortion of the discharge by the magnetic field, but why the deposit occurred principally where the field was most intense did not appear quite clear. A fact of interest, likewise noted, was that the presence of a strong magnetic



SPOKE WHEEL; DRUM WINDING; ALTERNATE MOTOR WINDING; RING WINDING.—Some of the designs produced by Intermittent Discharges.

* A lecture delivered before the Franklin Institute, at Philadelphia, February 24th, 1893, and before the National Electric Light Association, at St. Louis, Mo., March 1st, 1893.

field increases the deterioration of the electrodes, probably by reason of the rapid interruptions it produces, whereby there is actually a higher E.M.F. maintained between the electrodes.

Much would remain to be said about the luminous effects produced in gases at low or ordinary pressures. With the present experiences before us, we cannot say that the essential nature of these charming phenomena is sufficiently known. But investigations in this direction are being pushed with exceptional ardour. Every line of scientific pursuit has its fascinations, but electrical investigation appears to possess a peculiar attraction, for there is no experiment or observation of any kind in the domain of this wonderful science which would not forcibly appeal to us. Yet to me it seems, that of all the many marvellous things we observe, a vacuum tube, excited by an electric impulse from a distant source, bursting forth out of the darkness and illuminating the room with its beautiful light, is as lovely a phenomenon as can greet our eyes. More interesting still it appears when, reducing the fundamental discharges across the gap to a very small number and waving the tube about we produce all kinds of designs in luminous lines. So, by way of amusement, I take a straight long tube, or a square one, or a square attached to a straight tube and by whirling them about in the hand, I imitate the spokes of a wheel, a Gramme winding, a drum winding, an alternate current motor winding, &c. (fig. 34). Viewed from a distance the effect is weak, and much of its beauty is lost, but being near, or holding the tube in the hand, one cannot resist its charm.

In presenting these insignificant results, I have not attempted to arrange and co-ordinate them, as would be proper in a strictly scientific investigation, in which every succeeding result should be a logical sequence of the preceding, so that it might be guessed in advance by the careful reader or attentive listener. I have preferred to concentrate my energies chiefly upon advancing novel facts or ideas which might serve as suggestions to others, and this may serve as an excuse for the lack of harmony. The explanations of the phenomena have been given in good faith and in the spirit of a student prepared to find that they admit of a better interpretation. There can be no great harm in a student taking an erroneous view, but when great minds err, the world must dearly pay for their mistakes.

PROCEEDINGS OF SOCIETIES.

Institution of Electrical Engineers.

AT an ordinary general meeting held on Thursday, May 11th, Mr. W. H. Preece, F.R.S., president, in the chair,

The PRESIDENT feelingly alluded to the recent death of Sir James Anderson.

Mr. SAYERS then read his paper "On the Prevention and Control of Sparking; Continuous-current Dynamos without Winding on the Field-magnets, and Constant-pressure Dynamos without series Winding." This paper was published in our columns a few weeks ago.

In the discussion which followed—

Prof. S. P. THOMPSON said there were only one or two little details in the paper which he wished to reflect upon. He had once seen a very big ring-wound machine, an exaggerated case, in fact, of that to which Mr. Sayers referred, a machine with wide driving-pegs. That was a dynamo built in Paris by an engineer there who wished to make the manufacture more simple by winding in rings to get over the shuttling. He proposed to build the ring in two parts, winding each one separately and then screwing the two together by bolts. In evolving that mechanically there were two wide seams; the consequence was that he designed the commutator to match; it had 20 parts in one side and 20 parts in the other, with wide annular spaces to match the coils. The machine sparked most abominably. He then took off the commutator which had its segments spaced out, and put on an ordinary commutator with 40 spaced pieces, and though there was still some sparking and the thing wore down, there was less sparking than with the commutator specially designed to fit the segments of the armature. With respect to the point raised near the end of the paper about the narrow air space, of course all who took any interest in the details of machines were anxious to see armatures that should be more mechanical than those that had gone before, and when Mr. Swinburne first brought out those armatures with tunnels, and Mr. Brown began to build them in Switzerland, they felt that there would be no more armatures without self-winding. Those armatures undoubtedly had advantages, but they still possessed the disadvantage of sparking badly. Those magnificent machines designed for aluminium reduction at Mulhausen, by Mr. Brown, had to be sent back and the core discs turned down and the winding put outside as in the ancient winding of Gramme rings before they would consent to work without sparking. Mr. Sayers now showed what was the legitimate way of returning to that form of winding so that all the copper lay in the tunnels in the iron.

Mr. SWINBURNE did not think Mr. Sayers had laid enough stress upon the importance of the smallness of the connections. As regards the spaced commutator, he could not help thinking that Mr. Sayers was wrong theoretically about his dummy commutator. They had gone into the matter at Crompton's some time ago, and came to the conclusion that it would not do. It did not quite balance out if they put in a dummy commutator. It seemed to him that the days of smooth armatures were over. The only reason why they had not had hole-wound armatures for a long time was the difficulty of sparking. When he first advocated hole-wound armatures he was quite aware of the difficulty of sparking, and proposed various forms of reversing pole-pieces to get over the difficulty. They had discussed the matter at Crompton's, and although they had never made one, they had come to the conclusion that they were not practical things, not good enough to make commercially. He did not think engineers generally recognised the enormous advantage of hole-winding. Not only did they get a mechanical machine, an armature they could take out and roll about the floor without hurting it, but they got rid of the Foucault currents, as Dr. Thompson had pointed out, and above all, when working with a hole-wound armature they had no mechanical forces on the armature wire. The whole of the mechanical force came on the iron and not on the keeper, and that was a matter of very great importance when they were dealing with insulation. They had no longer to get their torque communicated through cotton, shellac, and messes of that sort.

Mr. HOUSMAN said: In practice the current curve during commutation was not a straight line, or anything like it; the exact shape of that curve depended a great deal on the gradient of the field in which reversal of the current took place. If the field was extremely steep—that is to say, if there were a rapid rise of E.M.F. from section to section—the curves would be extremely steep, showing the existence of currents which, he thought, Mr. Sayers supposed did not exist. He thought, in some cases, they did not exist; there was strong evidence for them in the variation of speed when the brushes were fixed, and he thought that was due to the fact that the back turns of the armature were not those simply due to the current multiplied by the armature currents included in twice the angle of lead. There was a point in connection with the commutation which was too often lost sight of, and that was the extreme importance of the surface resistance between the surface of the brush and the surface of the commutator. If the brushes were not placed in the proper position they had all the current crowded up into the front part of the brush, and there was a very considerable fall of potential at the tip, while at the heel there was no current, and, consequently, no fall of potential; and there was an E.M.F. round the circuit tending to help the reversal of the current. In the case of the ordinary copper brushes the surface resistance was about $\frac{1}{10}$th of an ohm in a square inch; in the case of carbon brushes it was three or four times greater, so far as he could measure, and he found that with the ordinary working full load of a dynamo they might have a fall of potential of ·3 or ·4 between the brush and the commutator, and, by shifting the brush forward and backward, in advance of and behind the position, they might have a difference of potential between the tip of the brush and the heel of about half a volt or so in some cases, and that half-volt represented a reversing E.M.F. which had, in a very much smaller degree, something the same effect as Mr. Sayers's invention. The same thing might be produced to almost any extent by having the connections from the armature windings to the commutator made of high resistance. It was not an uncommon thing, in America, for motors, where the brushes had to remain fixed the whole time, to have quite high resistances between the armature winding and the commutator. All the current went through one of them; the greater proportion of the dynamo commutation was not taking place smoothly, and, consequently, a difference of potential was set up between the two extremities of the coil and the commutation, and that tended to help the commutation. In the case of carbon brushes, he thought one of the principal benefits of them was that if the current was crowded up into the tip it did not stick to the commutator in the way that copper did if overloaded. It was often to be noticed that if a copper brush was overloaded the commutator immediately began to get rough, which he thought was due to the fusion of the point of the brush, owing to the current being crowded up to the tip; and as soon as the commutator began to get rough the condition of sparklessness was at an end, as there was no appreciable fall of potential at the surface, the two surfaces getting into immediate contact.

Mr. W. M. MORDEY did not quite see the necessity of having all the excitation on the armature. In some ways it was the best place to have the excitation, but in others the worst. It was the place where they could least spare space; they could not work with a nice low current density there as they could in the field, and there they had the field coil given the initial magnetisation. He should like to know what the difference in the current density was in the exciting coils, the armature considered as an exciting coil, and the field considered as an exciting coil, because he thought it would show how very much more economical a certain portion of the excitation would be as regards density if placed on the field-magnet. It had been asked what the limit was going to be. He supposed Mr. Sayers would say simply the heating. If a machine were self-regulating and sparkless, with no drag on the conductors, he thought there was no limit except heating. Certainly the efficiency would not suffer. Was it not the fact that with high tension direct current machines, hole-wound, or tunnel-wound, armatures were rather difficult to wind? The machines that had been wound in Switzerland had all been low tension machines, and there was nothing to do but put a solid bar of copper through the holes and insulate them. That was an enormous advantage, for when one had to deal with a bundle of wires, to get high tension, to insulate those wires from one another and from the frame and make the connections at the end, it was a much more difficult matter. He was not at all sure that it would be found possible, in small machines at any rate, for rather high tensions, to wind them through holes in that way. That difficulty he knew had been met in America, and the motors and generators so largely used on the tramways there, were wound on slots, but he believed they had had very great difficulties indeed with the insulation.

Mr. S. F. WALKER found fault most strongly with small clearance. He should not be surprised if Mr. Sayers found the armature touching a great many times. Good fitting, of course, would do a great deal, but they had to consider not only the fitting, but the hands the machine had to go into. They had to consider that the spindles would bend unless they were very stiff, and other problems, and to a certainty they would get the armature out a little bit, and it would be running on the poles from time to time, and do more harm than

good. All these devices for reducing the sparking and increasing the efficiency—were they worth the candle? When they got 1 or 2 per cent. efficiency, was it real efficiency? Was not the real efficiency what it cost to maintain, that was the interest on its first cost, the cost of coal and so on, and the cost of attendance? It was an old engineering principle that when you got beyond a certain point every 1 per cent. cost more than it was worth.

The meeting then adjourned.

AN ordinary general meeting of the Institution was held at the Institution of Civil Engineers on Thursday, May 25th, Mr. W. H. PREECE, F.R.S., President in the chair.

The discussion on Mr. Sayers's paper was then resumed.

Prof. W. E. AYRTON: It was more economical to produce the field by one magnetisation, than by two opposing magnetisations. The more the lead was forward the better, as regards efficiency and power, the motor worked. There was a plan which Prof. Perry and he discussed some years ago which might be worth mentioning. It had the advantage that you were able to work the dynamo with a negative lead, or to work the motor with a forward lead, so that the magnetisation due to the current round the armature helped the magnetisation due to the current passing round the field. It was to introduce outside E.M.F. altogether, to use two brushes at each side of the dynamo. They had two very narrow brushes close together to form the main brush, and a resistance was inserted which could be adjusted, and an E.M.F. was produced by an accumulator or other convenient means. They had a sufficient E.M.F. to produce the right current when the two brushes were on two adjacent coils. The resistance was adjusted so that all sparking was damped out and they could commutate, as Mr. Sayers did, more or less at any part of the surface they liked. He did not think this was so neat a method as Mr. Sayers's nor so self-contained, but at the same time might prove worth while trying, because it was a possible means of enabling them to commutate where Mr. Sayers did, and with an ordinary dynamo which had not an armature specially wound.

Mr. ALBION T. SNELL: At the present moment the limit to the output of a large dynamo were two, practically. The first was sparking and the second, heating. His experience, at any rate, had been that the output of a large armature was practically limited by the heating effect. He was afraid they were putting their compound coils in the wrong place. If they put them on the field they might have to put more wire and expend more energy, but the heat expended there could be readily controlled, whereas if the armature was overheated they could not very well afford to put more. The largest armature Mr. Sayers had built, so far, appeared to be one of 40 ampères. He had roughly calculated the output by slide-rule and estimated it to give something like 35,000 watts, so that if 40 ampères were successful the objections which he raised did not seem to have much weight. There was one application of Mr. Sayers's principle which struck him at once, and that was its application to motors. The problem of motors, particularly series wound for traction work, had been complicated very much by questions of weight, and although in stationary machines weight could be neglected, on a tramcar it could not; and if they could lessen the weight of a machine by 15 or 20 per cent. by means of this device—and it seemed quite possible—a very material advance was marked in connection with this purpose. He would also point out that the device seemed to be chiefly applicable to series-wound machines, for there was a possibility of doing entirely away with the excitation, but in connection with compound-wound machines they could only hope to do away with series coils. He was looking forward to the day when the dynamo and motor would work without a commutator.

Mr. ALEXANDER SIEMENS: Several speakers had referred to the sparking as a great enemy, and all that sort of thing, but he wished to emphasise the fact that it was not nowadays at all difficult to make dynamos which would run under any load without any change of the position of the brushes which would not spark at any time, and if anyone wanted to see such a dynamo, he was perfectly willing to show it to him. It was just the same with motors. It was not necessary for motors to spark so long as they were not absolutely overloaded, and he did not see the use of such an application at all. It might do all Mr. Sayers said; he had certainly done good work in making the experiment, and showing what could be done in that way, but he entirely doubted the utility of the device from the manufacturer's point of view.

Mr. MORDEY did not think the real point of Mr. Sayers's paper had been grasped. The real point was that he enabled them to approximate a direct current dynamo to a transformer. The excitation of a transformer required very little energy indeed; they were able in a transformer to do without any air-space, and air-space cost money, because they must supply energy to force the flux through it. It seemed to him that the point of Mr. Sayers's paper was not the placing of the commutator coils so much as that he enabled them to get a very small air-space, a mere mechanical clearance, that reduced the ampère turns from thousands to hundreds. He did that by the position in which he was able to collect the armature current for the purpose of supplying the large proportion of that excitation. Those ampère turns on the armature must be there anyhow. If that could be used, as Prof. Ayrton pointed out, for the excitation of the whole machine, so much the better; at present they did not use them. He quite agreed with Mr. Siemens that modern direct current machines ran sparklessly; but at what a cost. Look at a good modern two-pole or four-pole dynamo; look at the amount of copper on it; look at the many thousand ampère turns necessary to get the magnetisation of the armature; look at the magnetic field; look at the necessarily inefficient way in which they must apply the copper on the fields, the large quantity of it outside, and practically useless, mere end connections. It seemed to him that the real point was that they got rid of that great air-space without losing the great advantage of non-sparking and got rid of the necessity of putting a large amount of copper on the field and paying a lot of money for that copper.

Mr. CROMPTON: The dynamo machine, he believed, with Mr. Siemens and Mr. Mordey, had already arrived at sufficient perfection as regards the user, but it cost money to make, and if Mr. Sayers's improvements really had the effect of reducing the material and labour required in producing the dynamo or motor of a certain output, then he had achieved a great step in advance; but it was on that one point—and it was the sole point—on which they would ask him to throw light. What would be the comparative weight of materials employed, and what would be the comparative amount of labour employed, in producing a dynamo of given output? Mr. Sayers was working at a problem which had been before dynamo makers for the last six or seven years, that of reducing the air-space. He was sure Mr. Swinburne would corroborate him in saying that they had spent many anxious hours in discussing that problem. When he mentioned the names of Swinburne, of Brown, Ganz, and others on the Continent, all of whom had made sunk windings on the armature and all of whom had more or less failed, it would be seen that the problem was one that had engaged their earnest attention, and if Mr. Sayers by his invention and without extra expense did enable them to use some winding to reduce air-space, he had indeed made a great advance.

Mr. SWINBURNE: Prof. Forbes had referred to the difficulty of making a series alternating motor with a simple series-wound direct current machine with laminated fields. There were two main difficulties: the first was due to the self-induction of the machine—to use again a term to which he objected rather strongly, although it was admissible there, he thought. That induction could be overcome to a certain extent by condensers. But that was a serious objection; people did not want to put condensers in their houses with motors. The other difficulty had not been very fully realised; that was the objection of the sparking of commutators. As Mr. Mordey had pointed out, the armature might be regarded as a secondary. With the secondary in the armature that armature would develop very large currents when the brushes short-circuited two sections, very much larger currents than the E.M.F. generated now. He thought that might be got over by winding the armature double, as was sometimes done for large currents; in that way they would have two complete circuits round the armature. If their brushes were only the breadth of one section they never short-circuited a section, they simply passed from one armature circuit to the other.

Mr. SAYERS having replied, the meeting adjourned.

A NEW ELECTRIC RACK RAILWAY.

THE excellent situation of the towns of Barmen and Elberfeld in the Valley of the Wupper, surrounded by woody crowned hills, has for a long time caused the wish to be expressed for a suitable method of locally transporting the population; and the question of forming a connection between the town of Barmen, the pleasure grounds of the Verschönerungs Verein, and the Toelle Tower, was considered. Schemes were advanced for the construction of a wire rope railway and for a rack railway, with steam locomotives, but both were found unsuitable, and a project for a rack railway, to be operated electrically, was taken into consideration. This proved to be well adapted to the purpose, and Messrs. Siemens & Halske entered into a contract with the company then formed, the Actiengesellschaft Barmer Bergbahn, for the carrying out of the work. This mountain railway has now been completed; it has been passed by the local authorities, and will be opened in a few days. The following particulars of the line, prepared by Mr. Lerche, and presented at the meeting this week of the Society of German Engineers at Barmen, will prove interesting.

The railway, which commences in Cleferstrasse, passes by means of an iron viaduct over the Bergisch-Markisch State Railway, and after crossing the Kampstrasse on the level, it turns into the very steep Luisenstrasse; passing along this street the railway arrives at the Barmen Wood. In its further course the line forms a curve of 830 feet, and terminates on the heights of the mountain range near the Toelle Tower. Quite close to the end of this line is arranged a narrow gauge steam railway, which forms a connection with the Ronsdorf-Müngsten Railway, so that the favourite pleasure resorts may be quickly reached from Barmen.

The total length of the rack electric railway is 1,810 yards, or just over a mile, and the difference in level between the lower station and the upper terminus is 560 feet. The average gradient is 1 in 10, and the steepest, that in the Luisenstrasse, is 1 in 5. The curve in the latter street is of 490 feet radius, and that in Barmen Wood 830 feet. In addition to the terminal stations, there are two others, one in the Lichtenplatzerstrasse and the second in the Kohlenstrasse. The railway forms a double line throughout, and is of 1 metre gauge. A rack rail similar to the Riggenbach type, is laid in the centre of each pair of metals. That portion of the line passing along the streets is laid with Phönix grooved rails, but in the open Vignoles rails are used. Both the ordinary rails and the rack rail are carried in chairs bolted to iron transverse sleepers, placed at intervals of 3 feet 4 inches.

The cars are 26½ feet long and 8 feet 2 inches wide, and they each have sitting accommodation for 28 persons, and standing room for eight passengers. Each car is divided into four compartments, access to the two internal of which is from the side, and to the two end

compartments from the platforms. There are two motors, each of 36 H.P. to each car; they are arranged on the framework, and work independently. Each motor actuates motor gearing, driving pinions which gear into the rack rail. There is a separate brake to each axle, and an automatic brake, whilst a fourth is provided by the motors themselves. Turntables, operated by electric motors, are arranged at each end of the line for turning the cars round.

The current is transmitted from the generating station by an overhead copper conductor at a pressure of 500 volts, the conductor being arranged over the centre of the line at a height of about 16 ft. It is supported by insulators fixed to transverse span wires, which in the streets are fastened to Mannesmann iron pillars, and in the open, the span wires are carried on wooden poles. The current is collected in the ordinary manner by means of a trolley arm and wheel, and after passing through the motors returns by the rails, which are connected together by copper strips.

The generating station is situated in the basement of the lower terminal station in Cleferstrasse. It contains three Steinmuller water tube boilers working at 150 lbs., one being kept as reserve; two compound condensing engines, which at 165 revolutions yield 250 H.P., and which are direct coupled with two Siemens dynamos, generating at 500 volts.

It is proposed to enlarge the generating station, and to double the plant. The station supplies current not only for operating the railway, but also to private consumers for motive power purposes. It will also furnish power for the operation of the electric tramway, which is to be built in the autumn, and which, commencing in the Cleferstrasse, will terminate in the Hecklinghausen part of the town. This tramway, which will at first be a single line with suitable loops for crossings, will be equipped with eight motor cars in a manner similar to the electric tramways constructed by Messrs. Siemens and Halske, at Hanover and Dresden. A second line is projected for next summer from the Market Place to Wicklinghausen. In addition to this, there is projected a more important scheme—that of connecting Barmen and Elberfeld by means of an elevated electric railway.

NEW PATENTS—1893.

14,640. "A form of water-actuated electric switch." A. R. UPWARD. Dated July 31st.

14,643. "Beboutoff's automatical and electrical pile or monkey driver." P. A. BEBOUTOFF. Dated July 31st.

14,647. "Improvements in apparatus for working electric tramways by means of underground cables." C. ANDERSON. Dated July 31st.

14,664. "Improvements in electro-motors for alternating currents." J. A. KINGDON. Dated July 31st.

14,685. "Improvements in and relating to apparatus for heating and warming by electricity." L. H. HORDERN. Dated July 31st.

14,715. "Improved bell-pull arrangement for electric bells." E. G. HARCOURT. Dated August 1st.

14,742. "Improvements in or appertaining to electric light fittings." F. W. PLUMSTEAD and H. H. HUNTER. Dated August 1st.

14,756. "Improvements in dynamo-electric generators and motors." A. G. BROOKES. (Communicated by H. J. Ryan, United States.) Dated August 1st. (*Complete.*)

14,816. "An improved electromotor for boats and like purposes." A. A. LATEULERE. Dated August 2nd.

14,863. "Improvements in electrical resistances." A. CAMPBELL. Dated August 3rd.

14,868. "Improvements in electricity meters." J. THOMSON. Dated August 3rd.

14,910. "A method of and apparatus for electrolytical decomposition while using quicksilver as cathode." P. JENSEN. (Communicated by A. Sinding-Larsen, Norway.) Dated August 3rd. (*Complete.*)

14,953. "Improvements in regulating the supply of electricity to incandescent lamps." T. B. SHARP. Dated August 4th.

14,966. "Improvements in the construction of loud-speaking micro-telephones." E. MORWAY. Dated August 4th.

14,969. "Improvements relating to two-pole dynamos, motors, and the like." F. M. NEWTON and T. HAWKINS. Dated August 4th.

14,979. "Improvements in electric lighting and signalling apparatus for use on cycles and other vehicles." A. J. BOULT. (Communicated by C. Duvivier, Belgium.) Dated August 4th.

14,997. "Improvements in electric contacts for telegraphic vibrators." E. EDWARDS. (Communicated by P. la Cour, Denmark.) Dated August 4th.

15,001. "Improvements in telegraph forms." C. A. PEARSON and F. J. GALLAHER. Dated August 4th.

15,025. "An electric plant protector." F. A. J. FITZGERALD. Dated August 5th.

15,034. "An improved electrical and clockwork combination apparatus for the recording of workmen's time and like records." T. J. GOUGH. Dated August 5th.

15,050. "Slow striking electric bells." H. OPPENHEIMER. Dated August 5th.

15,064. "An improved electric arc lamp." F. W. SUTER and S. J. SUTER. Dated August 5th.

15,073. "Improvements in electric arc lamps." H. H. COOPER and THE ELECTRICAL INSTALLATION COMPANY, LIMITED. Dated August 5th.

15,074. "An improved electric coupling." H. H. COOPER and THE ELECTRICAL INSTALLATION COMPANY, LIMITED. Dated August 5th.

ABSTRACTS OF PUBLISHED SPECIFICATIONS, 1892.

1,436. "Improvements in friction-driving gear for dynamo-electric and other like machinery." J. Y. JOHNSON. (Communicated from abroad by A. de Bovet, of Paris.) Dated January 25th. Consists in providing the pulley of the dynamo with a coil of wire which, by means of a suitable device, such as two rings placed on, but insulated from the shaft, and two brushes, is caused to form part of the circuit of the dynamo. This wire is wound or coiled in the pulley, which may be enlarged or widened in order to provide sufficient space to accommodate the amount of wire required. Under these conditions, when the dynamo commences to generate or supply a current, the adhesion of the magnetised pulley to the motor wheel increases in the same proportion as the resistance of the machine increases, and thus ensures the continuous propulsion of the said pulley. 4 claims.

4,185. "A new or improved portable galvanic battery." P. STIENS. Dated March 3rd. Relates to an hermetically closed galvanic battery in which a constant current may be developed, by maintaining the electrolyte or solution in uninterrupted motion, and thus preventing crystallisation and the accumulation of the gases produced. 4 claims.

4,523. "Regulating sockets or holders for incandescent electric lamps and other translating devices." THE RIES ELECTRIC SPECIALTY COMPANY, E. E. RIES and W. S. HORBY. Dated March 8th. Consists in providing the lamp socket or holder with an annular core wound with a number of lengths of insulated wire, arranged in the form of a strand or cable, the ends of the several wires being properly cross-connected, and brought to a series of terminals arranged within the lamp socket in position to be traversed by an arm or contact brush attached to an operating key, in such a manner that the current supply to the lamp may either pass unobstructed through the socket without traversing any of the said wires, or may be choked or opposed more or less by being made to traverse in succession any desired number of the wires composing said strand or winding, or the supply of current to the lamp may be cut off altogether. 8 claims.

7,404A. "Improvements in or relating to dynamo-electric machines and electric motors." S. H. SHORT. Dated April 19th. Relates to dynamos of the Pacinotti type. 16 claims.

10,357. "Improvements in electric resistances." F. W. A. SCHNEIDER. Dated May 31st. Consists essentially of a mixture or composition commonly known as soap, and consisting of fat and caustic soda, or fat and any of the other cyrstal salts having like properties, such as potash, pearlash, alkali, binoxalate of potash, and the like. 3 claims.

11,353. "Improvements in electrical alarum clocks." D. J. MULLARKY. Dated June 17th. Has for its object the combination of the electrical part of the apparatus with the "movement" of the clock or timepiece in such a manner that, on the completion of the electric circuit, an alarum bell will ring for a considerable time until the circuit is broken by the continued movement of the clock, or by the personal movement of a switch, and to so arrange the "movement" of the clock or timepiece and electrical part of the apparatus, that the outward casing has the appearance of an ordinary clock or timepiece. 2 claims.

11,617. "Improvements in or relating to dynamo machines." C. J. HALL. Dated June 21st. Relates to improvements especially applicable to the kind of dynamo machine described in the application for Letters Patent dated 24th day of September, 1891, No. 16,250, in the names of R. Hammond and C. J. Hall. 4 claims.

11,692. "Improvements in electric locomotives." F. PURDON, H. E. WALTERS, B. MOTT, and J. P. O'DONNELL. Dated June 22nd. The objects of the improvements are to enable permanent way to be laid with curves of a smaller radius than those at present in use, and to enable the electric motors to be worked more efficiently by avoiding the excessive waste which now occurs in the resistance coils used for the motors. 8 claims.

11,698. "Improvements in insulators for overhead and other electric wires." F. MEYER. Dated June 22nd. Claim:—In an insulating carrier, or holder, for an electric wire having a head and a depending flange, a flange projecting annularly between the head and the flange, and downwardly bent to afford a protected groove or recess thereunder, which may be easily cleaned for the purpose of improving the efficiency of the insulator without increase in its extreme dimensions.

11,849. "Improvements in distribution and branch boxes for electric circuits." S. BERGMANN. Dated June 25th. The boxes, in accordance with this invention are lined on the inside with a substance made of paper or cardboard and somewhat resembling vulcanised India-rubber. 1 claim.

11,941. "Improvements in electricity meters." H. W. MILLER. Dated June 27th. According to the invention, the inventor adds to new or existing meters of the Aron type automatic devices which, in the event of one of the clocks stopping, will stop the second clock, thus preventing the record of the meter being lost, and further he provides a device which will disconnect the registration train of wheels from the clockwork during the time that no current is passing through the meter. 2 claims.

12,306. "Improvements in the construction of secondary batteries for electrical storage purposes." J. B. LEE. Dated July 2nd. Consists in constructing the battery elements of composite structures built up of cored rods of lead. 4 claims.

12,417. "Electric brazing and soldering devices." W. MITCHELL. Dated July 5th. Consists chiefly in the combination of a holder for the article or articles to be brazed or soldered, forming one terminal or electrode of an electric circuit, with a point or pencil forming the other terminal or electrode thereof, the said point or pencil being adapted to be directed to various parts of the holder at will, so that the heating action may take place at the point where soldering is needed. 4 claims.

12,436. "Improvements in electric insulators." H. H. LAKE. (Communicated from abroad by L. McCarthy, of America.) Dated July 5th. In an insulator embodying the invention, the metallic or conductive parts are separated by layers or sheets of mica laid and pressed together. 4 claims.

12,442. "Improvements relating to the lighting and heating of railway and other vehicles by electricity." L. D. ADLER, J. LOEWENBERG, S. YOUNG, and M. MOSKOWITZ. Dated July 5th. The invention is designed to utilise the waste energy from one or more of the car-wheel axles for driving or operating an air compressor which is connected with and which, in turn, drives an air engine, causing the latter to drive a dynamo, whereby the electricity is generated, either for lighting or heating purposes. 8 claims.

12,745. "Electric signalling apparatus." H. J. ALLISON. (Communicated from abroad by the STANDARD ELECTRIC SIGNAL COMPANY, of Rochester, New York.) Dated July 12th. Relates to electrical signalling apparatus, specially applicable to fire alarm systems, and comprehends in its application two main circuits, one leading from a central station to the building to be protected, the other to the fire department; also several sub-circuits and shunts for the proper operation of the apparatus. The arrangement is such that, in case of fire, the number of the building or station where the fire is located is registered at the central station, the alarm is sounded and the number given at the fire department, and a return signal is automatically sent back to the building or the locality of the fire, showing that the alarm has been given at the fire department. Furthermore, in case of the breakage of a wire or other disarrangement in the circuit, instead of fire, the signal is given and recorded at the central station without alarming the fire department. The fire alarm apparatus is operated through the instrumentality of thermostats interposed in the wires of the building or sub-station. 7 claims.

13,167. "Electric Arc lamp." W. E. IRISH. Dated July 19th. Consists of the combination of a thermo expansive electric conductor, a clutch, an operating lever and spring or similar devices for communicating the motions of the said conductor to the said clutch, and carbon electrodes engaged with said clutch. 4 claims.

13,221. "Improvements in or connected with telephones." W. DECKERT. Dated July 19th. Claim: In telephonic apparatus, the employment of a hollow cylinder, tube or funnel of paper, wood, India-rubber or other soft material in combination with either the microphone transmitter or the receiver, substantially as and for the purposes described.

13,549. "Improvements in dynamo-electric machines." F. V. ANDERSEN. Dated July 25th. Has for its object to design the machine in such manner, that the cost of construction shall be considerably reduced, the field magnet coil and working parts shall be completely closed in, in an improved manner, the magnetic circuit shall be principally of flat wrought-iron plates, and the brushes shall be automatically and efficiently adjusted for wear. 8 claims.

13,559. "An improved telephonic plant for private and domestic use." J. CERPAUX. Dated July 25th. Consists in the construction, arrangement and combination of parts of a complete telephonic plant or system for domestic or private use, the main advantage of which is that, to suit this purpose, the arrangements employed are considerably simplified and made more economical, especially for places already provided with electric bells, such as hotels, business establishments, private dwellings, &c. 1 claim.

13,562. "Improvements in and relating to electrical accumulators or secondary batteries." D. YOUNG. (Communicated from abroad by A. E. Colgate, New York.) Dated July 26th. The inventor first cuts out or produces in any well-known manner long, narrow, and comparatively thin strips or ribbons of metallic lead or other suitable material, with numerous rows of perforations through the same, disposed in any desired manner, but usually in transverse lines or rows. The strips or ribbons are then corrugated, and the corrugated and perforated ribbons are then twisted like a strand of yarn, but rather loosely, and only so as to convert them into approximately round strands. The strands thus prepared are woven, in any desired manner, into a band or series of plates. After the lead fabric has been produced in sufficient quantity, and generally in mats or plates slightly larger than is required of the finished plates, but of approximately the same shape, three or four of such mats are laid together upon one another and subjected to moderate pressure, whereby compound plates will be formed and sufficiently compacted to hold together in ordinary handling. The plates are then shaped by trimming their edges, and usually by melting or fusing the edges by a blow-pipe flame or hot iron. They are then fitted into cast lead frames by fusing together the parts of the plate and frame that are in contact. 7 claims.

13,639. "Improvements in mechanical telephones." A. L. SIMPSON. Dated July 26th. In this arrangement none of the parts are secured or fixed to the diaphragm, the whole being sustained in proper relation solely by the tension of the line wire. 7 claims.

13,648. "Improvements in electric railways." M. W. DEWEY. Dated July 26th. Consists in electrically communicating with a vehicle to propel it, by electro-static induction. 10 claims.

14,044. "Electrodes for secondary batteries." J. C. FELL. (A communication from abroad by W. Morrison, of America.) Dated August 3rd. Consists in providing suitable lengths of material to be acted upon by the current, which material is cut into strips of a ribbon or tape form, and, as a preliminary step, before being secured and built up in the form of a plate or electrode, in winding said lengths of ribbon or tape of material in the form of elongated coils, in such manner as that said coils have interior spaces extending from end to end thereof, and afterwards arranging a plurality or number of the coils so preliminarily constructed, side by side, in the form of a plate, and then securing them at their ends firmly in a fixed position by any suitable means, or in preliminarily positioning lengths or strips of said material, so as to form bundles, and afterwards arranging the bundles so preliminarily formed adjacent to each other, side by side, in such a manner, as to be built up in the form of a plate, and provide spaces between the bundles from end to end, and then securing the ends of the bundles firmly in a fixed position by any suitable means. 21 claims.

14,056. "Improvements relating to electric motors." H. H. LAKE. (Communicated from abroad by W. Stanley, Jun., and J. F. Kelly, both of America.) Dated August 3rd. Instead of simply dividing a main or single circuit of alternating currents into the two branch circuits for the field coils of a motor, and in parallel, as heretofore has been generally done, the inventors include the primary coil of a transformer in circuit with one of the field or energising coils of the motor, and connect its secondary through a condenser or polariser to the other energising coil or set of coils. 3 claims.

14,089. "Improvements in dry galvanic batteries." C. C. LESENBERG and J. VON DER POPPENBURG. Dated August 4th. Consists in filling the improved battery with finely chopped or ground fibrous materials, such as straw, chaff, and other vegetable matters; these substances are steeped in warm or hot water, and may then be used for filling the cells. Another characteristic feature of the invention is, that the chopped straw or other vegetable matter may be mixed with hydrates of carbon, such as dextrine, glucose or starch, and we add such a quantity of water that the entire mass is moist in itself, yet will not give off any water or moisture. A further characteristic of the invention consists in partly filling the carbon cylinder with a hydroxide of chrome prepared in a particular manner. This hydroxide of chrome is prepared by taking common bichromate of potash, dissolving it in hot water, and precipitating hydroxide of chrome by means of sulphuric acid. Hereafter the deposit is separated from the liquid above the same, and again dissolved in water. The carbon cylinder is steeped in this solution, so that it is soaked thoroughly with hydroxide of chrome, and we also place a small quantity of the precipitate into the hollow of the carbon cylinder, which is finally closed by means of a cork.

14,189. "An improved method of and apparatus for distributing alternating electric currents." H. H. LAKE. (Communicated from abroad by W. Stanley, Jun., and J. F. Kelly, both of America.) Dated August 5th. Consists in locating condensers or polarisation cells at the points of utilisation of the current. 1 claim.

14,814. "Improvements in storage batteries." E. P. USHER. Dated August 16th. The bottom and sides of the battery elements are enclosed by a flexible wrapper of vulcanised rubber compound, or the like, upon the surface of which inclined yielding lips are formed, with a grooved space between adjacent lips to receive the edge of the lead plate or frame and to hold such frame in its normal vertical position. The lips of each pair separate at the apex or line of meeting of their inclined surfaces, to receive the edges of a non-conducting separator sheet, interposed between the successive positive and negative plates, so that each plate is in a narrow pocket or chamber, and is held at its edges by the yielding lips and is shielded by the separators similarly held, so that any active material which may crumble may not come into contact with the opposite plate. The battery plates are cast as a thin sheet with a series of vertical ribs, flanges, or stiffeners projecting on opposite sides, between which ribs the active material is introduced, intermediate wells or spaces being preferably left open for more free circulation. The active material is in the form of tablets which may be introduced endwise after the plates and separators are in place. 7 claims.

14,816. "Improvements in electric battery plates." E. P. USHER. Dated August 16th. Consists of a tablet or shell of finely perforated lead foil or the like, filled with dry powdered oxide of lead, and having a central longitudinal conducting strip protruding from one end, and in a series of these tablets having their conducting strips united transversely, and also in such series of united tablets enclosed by a frame and side plates suitably bound thereto, forming a positive plate without an internal skeleton. Also relates to a series of united tablets held substantially parallel by transverse perforated strips or equivalent external binders which surround the several tablets and project therefrom to ensure an open space between adjacent plates and tablets for free circulation of the electrolyte. 5 claims.

15,167. "Improvements in or connected with electrically illuminated signs, advertisements, signal lamps, and the like devices." B. J. B. MILLS. (A communication from A. D. Page and E. J. McAllister, both of America.) Dated August 23rd. Consists in the devices comprising the improved universal sign, and applicable to advertisements, signal lamps, and the like devices. 6 claims.

15,690. "Improvements in overhead trolley for electric railways." B. KOCHS and A. KOCHS. Dated September 1st. The main feature of the invention lies in the fact that the trolley pole, if mounted upon a reversible base stand, need only be reversed in position to readjust itself to the wire in a different direction. 11 claims.